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ANNALS
OF
SURGERY

A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

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vol. 54 pt. 2

(VOLUME XLVI)

Oct. (JULY)-DECEMBER, (1907)

1911

182427
11/7/23

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ANNALS OF SURGERY

VOL. LIV OCTOBER, 1911 No. 4

ORIGINAL MEMOIRS.

A STUDY OF THE INFECTIONS.*

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HOSPITAL laboratories have for many years devoted their energies to the study of morbid tissues, but only occasionally to the bacterial origin of the infections. The desultory work which has been done has been in a few large hospitals connected with teaching institutions and a few others with ample means and a large laboratory staff. The study of infections from the bacteriological standpoint has not received the importance which it deserves. With the discoveries of Sir Almeroth Wright, however, and application of his principles to the creation of an artificial immunity in individual infections, the bacteriology of surgical diseases assumes new significance.

Important as the study of tissues undoubtedly is, particularly from the diagnostic standpoint, the study of the infections assumes at least equal importance, more particularly, however, from the viewpoint of therapeutics which is, after all, the goal of our art. The chief reason for the relative neglect of this important branch of hospital work has been, no doubt, the enormous amount of time which such investigations require. The average hospital pathologist, sometimes paid, more often unpaid, has quite enough to occupy himself with the tedious preparation of morbid tissues for the final judgment of the microscope without dabbling in the mazes of bacteriological work. If this branch of pathology is to receive the attention which its importance deserves, we shall have to add to our hospital staff a paid bacteriologist, who shall have nothing else to occupy his time save the hunting down of infection and the making of vaccines. From the writer's experience of more than three years with vaccines, it is his opinion that Wright's work has added a most valuable weapon to our armamentarium against disease. We have only begun to know how to use bacterial products. We are but on the threshold of our investigations into the problems which are involved in the production of artificial immunity. Antisepsis and asepsis secured us to a wonderful degree against wound infections following the surgeon's knife. Wright's methods promise a victory over primary infections against which our only remedies hitherto have been incision, drainage, and the natural resistance of the patient, which has too frequently proved insufficient to the task.

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* Read before the American Surgical Association, June 19, 1911.

A case of primary infection which occurred in the writer's service two years ago emphasized most strongly the prime importance of the fact that in each infection the bacteriological source should be traced. The case has been published in full in the *New York State Journal of Medicine,* but may be briefly referred to here.

In March, 1909, an Italian came into the writer's service at the Long Island College Hospital with a sinus leading down to some carious bone at the angle of the jaw. No cultures were taken previous to operation, and there was nothing to indicate the presence of anything unusual. Operation was done and the carious bone removed. The reaction to operation was somewhat severe but subsided and the sinus closed without incident, nor was there ever any serious infection of the face. A week subsequent to the operation the man began to complain of atrocious pains in the calves of the legs. Finally it was evident that an abscess had formed in the left calf, and it was opened and found to contain grumous bloody pus. Through the courtesy of the Hoagland Laboratory, cultures from the pus were taken at the time of the drainage. Subsequently a similar suppurative process occurred in the right forearm. The infecting organism, to the astonishment of everybody concerned, proved to be that of glanders, of which the patient had not a single symptom. There were no farcy buds, no nasal discharge, nothing save the suppurative processes in the left leg and right arm, which did not differ from ordinary metastatic foci, excepting the grumous character of the pus, which, while a feature of the suppuration of glanders, also occurs in other infections, being ordinarily simply an evidence of a low grade of resistance on the part of infected tissues.

Time does not here serve to go into the case at length. It was fully reported in the May, 1910, number of the *New York State Journal of Medicine* by the writer, the laboratory work being described by Dr. Benjamin White, the director of the Hoagland Laboratory. Suffice it to say that the organism gave the Strauss reaction with guinea pigs and agglutinated known cultures of the *Bacillus mallei.* An autogenous vaccine was made from the patient's own organism. He recovered after an illness of five months, and when last heard from had remained well. He had worked along shore previous to his illness, but had not been especially in contact with horses. Every effort was made to trace the source of his contagion but without success. One thing was certain—he had glanders.

This case is mentioned, not only on account of its interest because of the therapeutic success attending treatment, but also because it emphasizes in a particularly striking manner the necessity and the value of bacteriological work in connection with the infections. Had it not been for the friendly aid of the Hoagland Laboratory this man would have been treated as an ordinary case of metastatic abscess and many persons placed in great danger. With the possible exception of the bacillus of pest there is no organism which has claimed so many laboratory victims as *Bacillus mallei.* True, we ought always to exercise the greatest precautions in treating all infections, but when the treatment extends over weeks and daily dressings are required, vigilance is too often relaxed.

with results which are unpleasant with ordinary infections, but which might be deadly with so terrible an infection as that of glanders.

During the fall of 1910 the Directors of the Hoagland Laboratory offered to put at the disposal of the Long Island College Hospital the services of Mr. H. W. Lyall for bacteriological research into the origin of all surgical infections treated in the hospital. This offer was gladly accepted, and the cases here analyzed were those which came under the charge of the writer the past winter, together with a few others from the other operations in the hospital. A number of times Mr. Lyall went with the writer to the Kings County Hospital for similar investigations, and a few cases from that hospital are included in this report. The period of observation has been too short and the cases too few yet for our records to be more than suggestive. If attention is called to the great importance of this work so that it becomes a part of the hospital routine, which is not at present the case, the writer will feel that something has been accomplished.

BACTERIOLOGICAL ROUTINE.

Collecting of Material.—The following rules were observed:

(*a.*) Apply no germicides to an open lesion, or if such substances have been applied wash with sterile water and wait at least two hours before taking specimen.

(*b.*) Avoid contamination either from the person of the operator, instruments and supplies, the patient, or his environment.

(*c.*) Discard the first or top pus. Take the specimen from the depths of the lesion, thus avoiding dead or attenuated organisms.

(*d.*) Make inoculating smears upon the surface of at least two Löffler blood-serum slants.

(*e.*) Avoid exposing the cultured material to extremes of heat or cold and delay in incubator.

(*f.*) Make at least two smears upon glass slides and fix by gentle heating.

The only addition to these procedures is in the case of lesions whose cause is known or suspected to be a very delicate organism, *i.e.*, influenza bacillus, gonococcus, etc., when media richer in animal proteid is supplied, such as blood or ascitic agar.

Laboratory Procedure.—When the specimen reaches the laboratory it goes through the following routine:

(*a.*) Stains—Gram's method and with Löffler's alkaline blue and in certain cases an acid fast stain. This serves as an inventory and an attempt is made to recover from the plates all organisms thus demonstrated in the exudate.

(*b.*) Plates are prepared of suitable media, the usual one glycerin agar. The laboratory custom in plating is the use of the ordinary streak or the Conradi method.

(*c.*) Incubation of the plated material at incubator (37.5° C.) and at room temperature.

(*d.*) Under certain circumstances anaërobic conditions are supplied.

(*e.*) Study of and fixings from the colonies developed on the plates and isolation in pure culture.

(*f.*) Identification of species by the use of differential media, animal inoculation, and immunity reactions. Blood cultures are made through an incision of the properly sterilized skin over the median basilic vein. The blood is either immediately placed into the culture medium or first introduced into an isotonic and decalcifying solution. The latter method is used if culture material is not available at the bedside. For inoculation, 5 c.c. of blood are placed into at least 100 c.c. of fluid medium and the remaining 5 c.c. of blood are distributed in plates. The fluid medium most used is neutral broth. Under certain conditions dextrose broth, lactose bile, ascitic broth, and neutral broth to which calcium carbonate has been added are used. The plate medium ordinarily used is plain agar to which may be added ascitic fluid or other enriching material.

During the winter there were 108 cases of infection examined for the writer at the Hoagland Laboratory. The cases of ruptured appendix were not here included, some thirty in number, as the resulting cultures were so rich in intestinal flora that conclusions as to the infection were not of much value. Intestinal or sewage streptococci were quite common. The colon bacillus was invariably found, not often in pure culture. The first place among the flora of the intestine in appendical infections must always be given to the colon group. It occurred in over 90 per cent. of the cases. After that, to the streptococcus. We know little as yet about the varieties of the streptococci. There is one variety, however, the individual cocci rather small and clear cut, occurring in chains of five or six members and deeply stained, which is always associated with a virulent infection. Shorter chains of four or five members, the individual cocci rather large, have never been observed as associated with the severe types of inflammation. The 108 cases which we analyzed have been classified according to the infecting organism, and occurred as follows:

Staphylococcus aureus, pure culture	25
Staphylococcus aureus, mixed	18
Streptococcus pyogenes, pure culture	22
Streptococcus pyogenes, mixed	13
Staphylococcus albus, mixed	6
Colon, pure (not including appendix cases)	11
Colon, mixed	1
Pneumococcus, pure	11
B. Friedlander, mixed	2
Pyocyaneus, pure	1
Pyocyaneus, mixed	3
Diphtheroid, pure	1
Diphtheroid, mixed	22

The appearance of a bacillus closely resembling the Klebs-Löffler bacillus so frequently in 22 per cent. of the cases is perhaps the most interesting observation in this short series of cases. It occurred once in pure culture in a granulating sinus of the thigh, following an operation for necrosis; twelve times in association with the *Staphylococcus aureus;* twice with *Staphylococcus albus*, both times in acne cases; once in conjunction with the *Streptococcus pyogenes* and *aureus;* once with *Bacillus coli* and a sewage streptococcus. It also occurred in the medical wards with mild cases of sore throat not accompanied by exudate or any serious constitutional disturbances. One case is typical of all, as follows:

J. F. recovered from typhoid fever, complained of sore throat. No exudate. Cultures from swab could not be distinguished from true Klebs-Löffler bacilli. Neisser granules found. Not pathogenic to animals. Guinea-pig inoculated intraperitoneally after an interval of two weeks in good health; autopsied; adrenals clear; no adhesions; everything normal. This man was quarantined for two months by the board of health. During this interval he had no sore throat. This mild sore throat appeared in five post-typhoidal cases all in the same ward. In no case was the culture to be distinguished from the true Klebs-Löffler, neither was it considered to be a non-virulent diphtheria organism. Occurring in twenty-two cases of mixed infection it cannot be said, so far as was known, to have added to the severity of the case. It was most frequently associated with aureus (12 cases), next in frequency with the streptococcus (5 cases). Dr. C. F. Garside of the Hoagland Laboratory writes as follows concerning the classification of this organism:

> *Pseudodiphtheria Organisms.*—The following tentative classification of the diphtheria and diphtheria-like organisms has been adopted by the laboratory:
>
> 1. True, virulent Klebs-Löffler bacilli.
> 2. Avirulent Klebs-Löffler bacilli.
> 3. Hofmann's pseudodiphtheria bacillus.
> 4. *Bacillus xerosis.*
> 5. Diphtheroids: Organisms which resemble the true diphtheria bacillus in the following essential features: gram positive, non-motile, non-sporulating bacilli which show a parallelism in their arrangement in smeared preparations and which fail to take the alkaline methylene blue stain in one or more areas of their protoplasm, *i. e.*, beading or barring. These organisms differ from types Nos. 3 and 4 in their sugar reactions. Diphtheroids may be divided into the virulent and the avirulent. The methods used for differentiating these classes are, first, pathogenicity to guinea pigs, and, second, fementative reactions upon various sugars.
>
> 1. Animal pathogenicity: The avirulent Klebs-Löffler bacillus can be differentiated from the avirulent diphtheria-like organisms by its reaction on carbohydrates, notably its ability to ferment dextrin. The virulent true Klebs-Löffler bacillus can be separated from the virulent diphtheroids by animal inoculation, first protecting the experimental animal by immunizing it with diphtheria antitoxin, or by mixing the inoculating dose with diphtheria antitoxin. In either case the animal will survive inoculation with diphtheria bacilli, but will not be protected from the virulent diphtheria-like bacilli.
>
> 2. Fermentative reactions: Under ideal conditions distinct differences are brought out by this method, but certain variations in the reactions of the same strains, because of varied conditions, little understood and difficult to control, have cast some doubt upon the advisability of accepting such evidence as final. Consequently we rely upon the evidence supplied by animal inoculation of differentiation between the true Klebs-Löffler bacillus and its allied forms. For the present, the classification of the diphtheria-like organisms and the avirulent true Klebs-Löffler bacillus is based on their fermentative reactions and their cultural characteristics.

The importance of making the distinction between true Klebs-Löffler bacilli and the diphtheroid group cannot be overestimated. A hospital staff could easily get panic-stricken if the diphtheroids were not differentiated as indicated. In the absence of the clinical signs of diphtheria it is evident that the ordinary board of health methods will not avail, nor the presence of the Neisser granules, sometimes considered pathognomonic, be at all conclusive. The only trustworthy methods of differentiation are the behavior of the two organisms with the sugars, plus animal inoculation.

Four of the post-typhoid cases having diphtheroids in the throat were isolated and given special nurses, also isolated, for long periods of time, far longer than was necessary to determine the exact nature of the organism. The hospital and boards of health must always err on the safe side. At the same time we ought to recognize the fact that diphtheroids do exist which are non-pathogenic and, so far as known, without influence on wounds. The single case in which a pure culture of diphtheroid was isolated from a granulating sinus recovered without any untoward symptom. Further observations on the behavior of this organism in wounds and its influence thereon are most desirable.

The number of closed infections with pure cultures of aureus, streptococcus, pneumococcus, and colon bacillus was of great interest. It was impossible to trace the path of the infection in any of the cases, as they were all seen late in the course of the affection when a definite abscess had developed, and it was not possible to discover the origin, whether hæmatogenetic or by the lymphatic paths from mouth, tonsil, or the intestinal tract.

The following cases of aureus infection were not preceded by abrasion or wound. From a subdiaphragmatic abscess a pure culture of aureus was obtained. No history of ulcer of the stomach obtainable; no pleurisy. Six cases of prepatellar bursitis were treated and cultured. Like the carbuncles of the neck, of which there were five, from all a pure culture of aureus was obtained. One of the cases of prepatellar bursitis was opened early before sinus formation. The swelling was of two weeks' standing. There was no abrasion of the skin. Pure aureus was obtained from the abscess cavity when opened. A case of osteomyelitis of the lower end of the tibia in a child of twelve years, of unhealthy appearance, had been preceded by several aggravated furuncles of the face. Cultures obtained from the bone abscess when opened proved to be aureus. The furuncles had healed at this time and could not be cultured. Many cases of osteomyelitis are said to be preceded by tonsillitis. It is evident that in all these cases of osteomyelitis the infection must be by the blood stream and not against the lymphatic current by way of the lymphatics. A second case of osteomyelitis, a Brodie's abscess, was as follows:

A young woman of twenty-five years, domestic, came under the writer's care suffering from pain in the lower portion of the left tibia and a temperature range of 100°–102°. Eight years previous she had suffered from an osteomyelitis of the same tibia, which had been operated. After recovery the intervening years had been free from illness until two weeks before writer saw her. The Röntgen ray showed a shadow at the lower end of the tibia about four inches from the malleolus. On cutting down on this spot the bone percussion note was dull, and, on trephining, a well walled off abscess cavity was found, cultures from which, made from the interior of the bone cavity, proved to be mixed, albus and streptococci in long chains. The cavity was filled with bone wax and the patient made a good recovery.

It is difficult to trace the infection in this case or to see why albus, which is a skin organism, should have gotten into a closed bone abscess in conjunction with a streptococcus infection. Moreover, this is the only case in which a closed abscess gave a mixed infection. It is possible for these organisms to have remained in the bone, from time of the first operation, but it does not seem likely in view of the rather delicate nature of both organisms. Aureus has been known to remain viable for years, but so far as the writer knows, not albus nor the streptococcus group, which die rather easily. Three aureus abscesses of unknown origin were opened. One of these was inguinal, no injury, no urethritis; swelling of two weeks' duration drained; culture, aureus. A second abscess, subfascial, not associated with sore throat nor tonsillitis, was opened at the angle of the jaw and proved to be also aureus. There was no carious bone nor dental caries in connection with this case. The proximity to the mouth suggests a lymphatic course for the infection.

A most interesting case was as follows:

The writer saw in consultation a man fifty-seven years of age with the following history: He had been treated for two weeks by his brother, a physician, for grippe. He had a chill, fever to 103°, malaria. Later pain in the right wrist, some swelling, then pain in the region of the right hip, œdema, swelling. An exploring syringe revealed the presence of an abscess under the fascia lata, which was drained, cultured, and proved to be pure aureus. It is difficult to trace the origin of this infection. The patient made a good recovery and never showed any evidence of infection elsewhere. The affected wrist suggests a hæmatogenetic origin, but it was not possible to say that there had been an endocarditis, and in view of the extremely fatal character of endocardial infection of the aureus type, the inference is that no endocarditis had preceded the attack.

A somewhat similar case to this treated by the writer occurred in the person of a lady, who for three weeks previous to her coming under the care of the writer, had recurrent attacks of what was diagnosed as Pfeiffer's glandular fever. The attack had also been called grippe. Each of the weekly attacks had been preceded by chill, fever, malaria; the last by some swelling in the neck anterior to the left sternomastoid muscle. This finally proved to be an abscess underneath the deep fascia of the neck and was drained. A streptococcus was cultured from the pus, but was a slow grower, not showing any growth until the fifth day. This lady developed a soft murmur at the aortic orifice, developed septic wrists and knee, had three convulsions, although the urine was negative, but finally recovered after the use of a vaccine which was not autogenous but came from the organism of another patient.

Abscesses occurring in post-typhoid are usually found to contain typhoid bacilli in pure culture. This is not always the case, as the following case shows:

A patient in the fifth week of typhoid, convalescent, developed an abscess at the right wrist, an abscess of the left leg, an abscess in both arms. Cultures taken from these abscesses proved to be aureus, streptococcus, and diphtheroids. From a tubercular sinus of the neck exactly the same organisms were recovered, although the patients were in different wards and under different house officers and nurses. The streptococcus occurred in pure culture 22 times, but was by no means always of equal virulence. In one case after a pin prick, the cellulitis started in a few hours and involved the lymphatics to the shoulder in 48 hours.

One curious case of streptococcic infection was as follows:

A negro came into the writer's service in the Kings County Hospital with a swelling of the axilla and upper arm. His story was that his employer had been operated upon at home for an abscess of the arm and he had cleaned up the room after the operation. The following day he complained of pain and swelling in the right arm and came to the hospital for treatment. The hand was carefully examined for a scratch or abrasion of any kind, but none was discovered, nor was the hand affected at any time, the infection being restricted to the area above the elbow. Drainage showed a pure culture of the streptococcus. Another abscess of the axillary fossa without history of injury or abrasion showed a pure culture of streptococcus in short chains.

The most likely source of contagion in abscesses of this type and in perhaps all subcutaneous abscesses not of traumatic origin is in an infected sweat gland or hair follicle. There was no evidence in any of the cases beyond conjecture that either of these was the starting point of the infection.

Two cases of streptococcic infection occurred in fractures. The first was in the writer's service at St. John's Hospital and was subsequent to the application of a Lane plate for bad oblique over-riding fracture of tibia and fibula, with great displacement. The writer has used the Lane plate in nine cases during the past winter with good results, except in this case, which he relates in order that it may at least serve as a warning against the indiscriminate use of the open method in this treatment of fractures. The subject of the fracture was a young man of alcoholic habits, who received the injury as a result of an automobile accident. The case was ideal for the open method, as the bones, when reduced could not be held but slid past each other with much over-riding. The operative field was most carefully prepared twice after the usual method. After the patient was in the operating room, the leg was painted with tincture of iodine, which was allowed to dry. Every one connected with the operation wore rubber gloves. There was very little handling of the tibia to which the Lane plate was secured, resulting in perfect apposition. The fascial wound was closed with catgut, the skin with silkworm gut, a dressing applied and a plaster case. The wound showed evidence of infection on the second day and a window was cut in the case, the sutures removed, and pus found which was of streptococcus origin. Every effort was made to trace the error in technic if any. The gauze, the suture and ligature material were tested and the samples taken shown to be sterile. The nasal cavities of every one concerned in the operation were cultured and no streptococci found. There was not another streptococcus case in the hospital, and the writer went straight from the operating room of this hospital to another hospital and did three operations, one a gastro-enterostomy, all of which recovered with primary union. Drs. Avery and Garside of the Hoagland Laboratory made every effort to hunt down the source of contagion but failed. The patient ran the gauntlet of prolonged suppuration, multiple incisions, necrosis, and is now, five months after the operation, just beginning to get union. Was the source of this infection hæmatogenetic? In view of the many cases of closed infection which occurred in this series without the intervention of any injury, we cannot absolutely deny the possibility that an operation wound may become infected from within and not from without.

The other streptococcus infection occurred secondarily in a compound fracture of the tibia, which had been wired at the Coney Island Hospital. Three months afterward the attending surgeon did an operation for the removal of some necrosed bone. This was followed by a rise in temperature and evidences of severe infection. The writer saw the case the week after the operation for necrosis, and on examining the patient's heart found a soft blowing murmur. Diagnosis, septic endocarditis, probably of streptococcic origin. Blood culture showed 100 colonies of streptococci to the cubic centimetre. In spite of treatment by vaccines and antistreptococcic serum this patient died. No cultures were taken from the wound prior to the second operation. The writer desires to make the point that this should have been done, and immunizing doses of the organism found and given prior to the second operation. It is evident that a bacteriological examination of the old wound prior to operation might have served to put the surgeon on his guard and might have avoided a catastrophe.

Seven cases of puerperal infection occurred in this series of cases, of which four were of pure streptococcic origin. In these four cases blood cultures were taken and streptococci recovered as follows:

A. T., January 12. Induced abortion; culture shows long chain streptococci, 200 colonies in 0.5 c.c. of blood; death.

Mrs. E., puerperal sepsis eighth day; blood culture: streptococci in long chains; 12 colonies in 2 c.c. of blood. Culture from cervix streptococci. An autogenous vaccine was made for this case and she recovered but developed a deep abscess of the right hip, subfascial, running in the direction of the thyroid foramen. This was drained, and cultures taken proved to be streptococcic in character. Ten days after drainage she again developed an evening rise in temperature. Careful examination showed no retained pus, no abscess or evidence of inflammatory process in the pelvis. She again received an autogenous vaccine and the temperature fell to normal, after which she recovered. This is the second case of abscess of the upper thigh occurring secondary to a puerperal infection observed by the writer lately. It is possible that it is of lymphatic origin via the lymphatics which accompany the obturator artery and vein into the pelvis.

CASE IV.—Induced abortion six weeks previous. Patient seen by family physician one week after the operation for abortion; temperature 104°; had been told by "operator" that she had grippe. Sepsis six weeks' duration; no phlegmon. Seen then by writer. Marked endocardial murmur. Pelvis clear. Septic wrists and knees, chills; temperature 102°–104°. Blood culture showed numerous streptococci, colonies not counted. The administration of a polyvalent vaccine (Van Cott's formula) and subsequently an autogenous vaccine followed by a remission of all the symptoms. A week later, however, patient embolized her left middle cerebral and also developed septic infarcts in both lungs and died.

The three cases of mixed infection were as follows:

Peritonitis following abortion. Death. Swabs from peritoneal cavity at autopsy showed streptococci of the large variety, the chains occurring end to end, probably the intestinal streptococci and diphtheroids developing in a very delicate growth on the culture medium.

Case II.—Mixed infection, puerperal sepsis following delivery by students. *Staphylococcus aureus*, *albus*, and *Streptococcus longus*. Recovery.

Case III.—Sepsis following delivery; brought to the hospital. No blood culture; vaginal swab showed colon and albus. Recovery.

Of these seven cases all were streptococcic in type except one in which only colon and albus were found. This was of mild type. Six of the cases were induced abortion.

The pneumococcus in pure culture was usually found in the empyemas, when there was an intercurrent or preceding pneumonia. There were four cases of special interest of pneumococcus infection in cases not empyema.

Case I.—A. B., Kings County Hospital. Dry pleurisy, right side, followed by a painful swelling at the region of the right sternoclavicular joint which appeared quite rapidly. Pus from the drainage operation showed a pure culture of the pneumococcus.

Case II.—Pneumococcus infection of the right knee-joint. This was a man in the Kings County Hospital who came into the service after an illness of two weeks. His account was that the right knee became swollen and painful after a fall which did not bruise the knee or break the skin. Patient thought he had rheumatism. Examination showed a much swollen knee-joint full of fluid; temperature 101°–104°. Aspiration proved the contained fluid to be pus. Culture showed a pure pneumococcic infection; no pneumonia; no pleurisy. The Mayo operation done for drainage. Pus found to have escaped from the capsule into the intermuscular planes. Attempts to save the limb in vain and patient died.

Case III.—Compound fracture of the head of the humerus in a stout woman of forty-eight years, Kings County Hospital. Wound enlarged; head and shaft joined by Lane plate. Infection, pneumococcus, drainage. This patient did well for a time, but the arm was subsequently removed at the shoulder for a renewal of the infection by the writer's successor in the service.

Case IV.—Pneumococcic conjunctivitis, contracted from patient's daughter and when first seen was thought to be of gonorrhœal origin. Cultures showed a pure pneumococcic infection.

All the cases of suppuration in which the pneumococcus was found were of a severe type. The empyemas were classified as follows: those following pneumonias, in all but one of which pure cultures of the pneumococcus were found. In one case, that of a child who came to the hospital with fluid in the right chest, a bronchopneumonia had been present and the cultures from the drainage operation showed aureus and diphtheroids, the former predominating. An empyema said to have followed an attack of influenza was aspirated, but cultures from the aspirated fluid, though this was turbid, remained sterile. Resection of a rib was done for free drainage. Cultures from the drains gave a Gram negative bacillus which proved to be Friedlander. This patient died. The drained fluid was thin and bloody.

An interesting case of encysted empyema was that of a patient, a man fifty years of age, with cough and expectoration suggesting tuberculosis. No tubercle bacilli, however, were ever found in his sputum though frequently sought for, but numerous streptococci. The Von Pirquet reaction was negative.

He developed an encysted pleurisy just posterior to the angle of the scapula, which was drained. Cultures taken from the drainage showed pure streptococci. Although perfectly free drainage had been provided, patient continued to run an evening temperature. Finally he received a vaccine made from his own organism, after which his temperature fell to normal.

Five cases of perinephritic abscess came under the writer's observation and were drained. Four of these were pure aureus, one a colon infection. On the contrary all of five cases of unilateral hæmatogenous infection of the kidney showed pure cultures of the colon bacillus, the cultures being taken from the small abscesses in the renal cortex after hemisection of the kidney, subsequent to the nephrectomy. No deductions can be drawn from a few cases, but one would naturally expect perinephric abscesses to be the result of colon infection rather than aureus, owing to the proximity of the colon. In the infected kidneys, the origin was clearly hæmatogenetic, as the abscesses occupied the location of the vascular tufts. This variety of infection is probably never the result of an ascending infection of the bladder, the symptoms being quite different from and far more severe than a simple pyelitis or even a pyelonephritis.

This short collection of cases is submitted with much diffidence. Yet few in number as are the cases, the labor involved in the isolation of the infecting organisms has been very great and has consumed much time. It is the intention of the writer to continue the work with the assistance and collaboration of the Hoagland Laboratory. In course of time it may be possible to make conclusions of value. It is not impossible that we may find a method of immunizing a patient against infection previous to operation or to sterilize the blood current and tissues after infection has occurred. That is what Ehrlich has done in syphilis.

The writer gratefully acknowledges the assistance of Drs. White, Avery, Garside, and Mr. A. W. Lyall, the bacteriologist to the Long Island College Hospital, without whose aid this work would have been impossible.

THE ANATOMY OF SPINAL PUNCTURE WITH SOME CONSIDERATIONS ON TECHNIC AND PARALYTIC SEQUELS.*

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OF NEW YORK,
Assistant Visiting Surgeon to St. Vincent's Hospital.

(Anatomical research through the courtesy of the New York University and Bellevue Hospital Medical College.)

The topic includes a consideration of the propriety of tapping the spinal arachnoid sac in any region of the cord below the midcervical. For emphasis, *the conclusion from these studies is stated at the very start,* that the only vertebral interspaces through which puncture of the subarachnoid space can be made with practical assurance that nerve structure will not be penetrated, are the fourth lumbar and the lumbosacral, preferably the former. This statement presupposes the employment of a correct technic.

Key and Retzius[1] in 1828 published extensive studies of the subarachnoid space. They injected the subarachnoid space with a blue color fluid and then made frozen sections of the cord. They state that the anterior subarachnoid space of the cord is entirely free and open, but that the posterior space in the dorsal region is divided up by interrupting membranes attached in the lines of the nerve-roots. Their only suggestion of an adhesion between the posterior surface of the cord and the arachnoid membrane is contained in the following words: "At the lowest part of the cord the conditions change essentially. The posterior septum, if we include under this name the posterior arachnoid midmembrane and trabeculæ, is usually very richly developed and contains a number of larger and smaller subarachnoid spaces, at times breaking up into a thick trabecular network which occupies a large portion of, indeed almost the whole, space behind the cord between the nerve-roots" (Key and Retzius, i, p. 91).

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* Read before the New York Surgical Society, April 26, 1911.

They describe a constant valve-like flap in the upper part of the anterior subarachnoid space between the levels of the second attachment of the ligamentum denticulatum and the fourth cervical nerves, convex upward, which permits a free flow of cerebrospinal fluid from brain to cord in front of the ligamentum denticulatum, but obstructs the free passage of cerebrospinal fluid from cord to brain, within this area. Propping[2] has proposed that the opening and closing of this valve with the falling and rising respectively of the spinal fluid, occasioned by the respiratory movements, by alternating a greater opening for ingress of cerebral fluid to the spinal subarachnoid space, with a smaller opening for egress of the spinal fluid to the cranial subarachnoid space, were causative of an active circulation between cranial and spinal subarachnoid fluids.

Quincke,[3] and Gerstenberg and Hein[4] have made original anatomical studies of the spinal cord. Quincke describes the close contact of the spinal arachnoid with the dura surrounding it, as analogous to the relation between adjacent pleural or peritoneal surfaces. He describes the cauda equina as divided into two lateral halves separated by a mesial cleft from 2 to 5 mm. in width. This corresponds to the variety of distribution of the nerve-roots of the cauda equina found in Dissection C of this article. The conus medullaris in very young children lies lower than in adults. Quincke says in this regard: "In eight cadavers of children up to one year of age I found the end of the conus at the level of the third lumbar vertebra, in children three years old at the level of the second lumbar vertebra—only once in a four-year-old child at the level of the fourth lumbar vertebra."

Gerstenberg and Hein state that the position of the nerve-roots of the cauda equina in the subarachnoid space is variable, sometimes the roots lying close to the posterior and lateral walls and again nearer the anterior wall. They give as the usual condition, that in which the nerve-roots divide into two lateral halves, leaving the anterior wall of the space free. They describe the subarachnoid space of the spinal region above the cauda equina as divided by the garland-shaped ligamentum denticulatum into an anterior portion and a posterior portion, the two portions communicating with each other through the spaces between the concavities of the ligamentum denticulatum and the arachnoid sac. Also they note the presence in this space of a posterior median septum in which are holes affording communication between the two sides. These authors have described the extradural veins within the spinal canal. Venous arcades cross the posterior surface of the dura, underlying the bony arches, so that the main vascular channels posteriorly are out of the line of puncture. Anteriorly these veins, which lie on the posterior surfaces of the bodies of the vertebræ, are much larger and more numerous than the posterior ones. With their condition of distention or of collapse the content of cerebrospinal fluid in the subarachnoid space is regarded to vary.

Magendie[5] connected a tube with an animal's subarachnoid space and saw the cerebrospinal fluid rise and fall in the tube synchronous with the movements of respiration.

Propping brings out the fact that the fat at the intervertebral foramina, which is displaceable, and the peridural veins accommodate the changes of intradural pressure.

The writer has observed that the sizable anterior extradural veins of the lumbar region, which are mesially situated, occupy exclusively the transverse hollows on the posterior surfaces of the bodies of the vertebræ between the projecting upper and lower bony margins, and are separated from the dura by the posterior common ligament of the spine, which bridges over the hollows. Between these transverse hollows, in the mesial area of the spine, the intervertebral disks, together with the lipped margins of the adjacent vertebræ above and below, form projecting surfaces measuring about three-fourths of an inch in a vertical direction, which act as piers to support the posterior common ligament, over which areas there are no sizable vessels. Only over the lateral portions of the posterior surfaces of the bodies of the lumbar vertebræ, just within the line of the intervertebral foramina, do the venous plexuses pass upward and downward in the vertical direction. This anatomy has the following surgical importance: that, since the intervertebral disks are situated in the line of a straight forward puncture between two adjacent lumbar spinous processes, with a mesially directed puncture it would hardly be possible for the most inadvertent operator to pierce any of the anteriorly lying extradural vessels.

The writer presents in this paper his findings in fifteen dissections of the spinal cord, in all of which the anatomy of the cauda equina was studied, and in eleven the portion of the arachnoid membrane in relation with the posterior surface of the cord from the conus medullaris up into the cervical region was carefully dissected.

With the exception of the diagrammatic cross sections, the illustrations in this article are either photographs or drawings from photographs.

Especial pains have been taken to demonstrate by these illustrations the varying relations of the arachnoid membrane to the nerve structures, which relations are all-important in establishing a site of greatest safety for tapping the subarachnoid space. Thus localities where the posteriorly lying arachnoid was found adherent to the surface of the cord or to an agglutinated mass of nerve-roots of the cauda equina, would manifestly be unsuitable for puncture.

The writer has located the upper borders of the lumbar pedicles (and the intervertebral disks immediately above them) as corresponding to the levels of the intervals between the posterior extremities of the spinous processes, so that in studying the illustrations, the sites of entrance into the spinal theca of a needle introduced through different lumbar interspaces can be estimated from the situation of the pedicles.

PUNCTURE AT AND ABOVE THE LEVEL OF THE CONUS MEDULLARIS (Figs. 1 and 2).

The anatomical findings in the eleven dissections of the arachnoid membrane, from the conus medullaris up into the cervical region, were condemnatory to the procedure of puncture within this area, as one attended with the greatest liability of penetrating the cord.

In the whole 15 dissections, the conus medullaris was 11 times found at the level of the first lumbar vertebra, 3 times at the level of the junction between the twelfth dorsal and first lumbar vertebræ, and once reached to the lower border of the second lumbar vertebra.

Of the eleven dissections of the arachnoid membrane above the conus, in but three—which included Dissections F (Figs. 14 and 15) and G (Figs. 16 and 17)—was there a complete posterior arachnoid space present all the way up into the cervical region. In all of these three there were at intervals interrupting transverse septa, so that the channel posteriorly was not continuous. However, its lateral communications with the anterior portion of the subarachnoid space over the concavities of the ligamentum denticulatum provided opportunity for a free circulation of the cerebrospinal fluid. In a fourth dissection the posterior arachnoid space was present throughout, excepting for an adhesion of the arachnoid membrane to the cord for an interval of about half an inch opposite the first dorsal vertebra. It, as well, was partitioned by the usual interrupting septa in other situations. In three dissections (including D, Fig. 12, and E, Fig. 13), the arachnoid membrane was adherent to the pos-

Fig. 1.

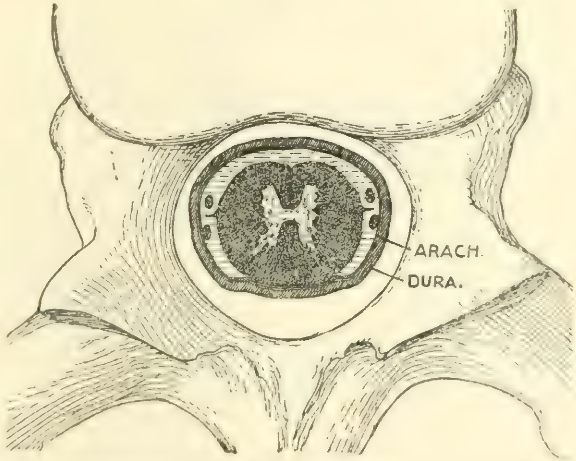


Diagram of a cross section through the dorsal spine, showing how the arachnoid membrane may be adherent to the posterior surface of the cord, which was the predominating anatomical arrangement in this and the lower cervical regions in six out of ten dissections. The close contact between the arachnoid and dura is here illustrated.

terior surface of the cord all the way from the conus up into the cervical region. In one dissection the arachnoid membrane was completely adherent to the posterior surface of the cord above the level of two inches above the conus, in another, above the level of three inches above the conus, and in two others, above the levels of the fifth and seventh dorsal vertebræ respectively. In the last mentioned case the arachnoid membrane was likewise adherent over the anterior surface of the cord from the level of the ninth dorsal vertebra upward into the cervical region. Laterally in this case, however, the subarachnoid space was open.

Fig. 2.

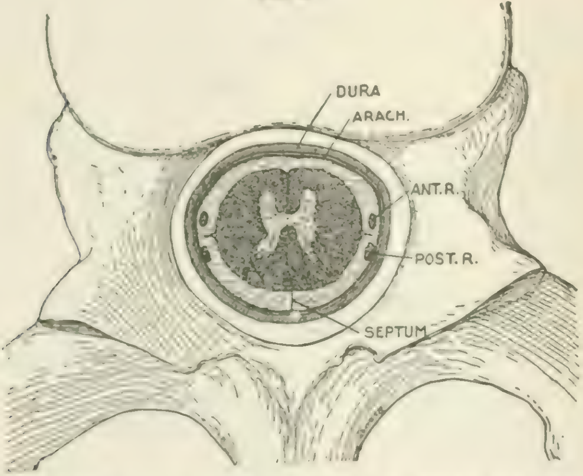


Diagram of a cross section through the dorsal spine, showing how the subarachnoid space may completely surround the cord. An anatomical arrangement of the posterior part of the arachnoid sac like that here pictured was found to exist throughout both dorsal and cervical regions in but three out of eleven dissections and in these the continuity of this posterior part of the channel was interrupted at intervals by transversely lying septa. There is free communication between the anterior and posterior portions of the subarachnoid space through the openings between the concavities of the ligamentum denticulatum and the arachnoid sac. ANT. R., POST R., nerve-roots.

The *conclusion* is that if cerebrospinal fluid can be constantly drawn as a result of mesial puncture at or above the level of the conus, in many instances the substance of the cord must be traversed by the needle and the fluid taken from the anterior portion of the subarachnoid space.

Illustrative of the danger of perforating the cord in tapping the subarachnoid space through the dorsolumbar inter-

space, were the findings in Dissections D and E. In each of these cases, the conus terminated opposite the first lumbar vertebra and there was an adhesion of the arachnoid membrane over its posterior surface. In another one of the dissections, in which the tip of the conus was at the level of the disk between the twelfth dorsal and first lumbar vertebræ, the lumbar arachnoid sac extending free posteriorly only up to the V-shaped outline of the conus, and above becoming adherent to the cord, it would seem quite certain that here, too, to have drawn cerebrospinal fluid as a result of tapping in the dorsolumbar interspace, the needle, which would have been directed about opposite to the tip of the conus, would have had to have penetrated through the nerve structure into the anterior subarachnoid area. In each of eight other of the dissections in which the relations of the arachnoid membrane to the posterior surface of the cord opposite the dorsolumbar interspace were investigated, there was found present in this locality a freely open subarachnoid space, so that in these cases it would have been possible to have punctured the arachnoid sac through this interarcual interval, without injury to the cord.

It is of importance in this connection to consider the work of Rehn,[6] who injected physiological doses of tropacocaine, novocaine, and stovaine into the spinal cords of animals, causing immediate death with typical medullary symptoms. This result occurred regularly, even with diminishing the doses of the drugs to very small amounts. To test whether the effect of these injections was mechanical or toxic, physiological salt solution alone was injected into the spinal cords of animals without any recognizable effects.

A review of some of the cases in which sudden death has occurred soon after the injection of a spinal anæsthetic would embellish this trend of thought.

Especially pertinent are those cases in which the puncture was made in the dorsolumbar interspace. Such cases are, however, few, owing to an almost general obedience to Quincke's precept early laid down, that spinal puncture should be made only below the level of the conus medullaris. Also of interest in this connection are deaths under spinal anæsthesia, for which definite pathological lesions were found at autopsy to have been accountable.

Cases associated with high pelvic elevation, in which, probably from the heavy specific gravity of the solution used, or from a shifting of the spinal fluid cranialwards, the respiration has become paralyzed beyond the power of restoration, have been here omitted as irrelevant.

Fatalities During Operations Under Spinal Anæsthesia, Other than Cases of Respiratory Paralysis Associated with High Pelvic Elevation.

(*a*) *Where dorsolumbar puncture had been made.*

Milward (F. Victor): *Death under spinal anæsthesia by Jonnesco's method in a case of acute intestinal obstruction. British Medical Journal, March 26, 1910, p. 743.*

Intestinal obstruction. Injection of 10 cg. of stovaine and 1 mg. of strychnine in 1 c.c. of water between the eleventh and twelfth dorsal vertebræ. Head raised on a thick pillow. In 7 minutes the pupils were dilating and the pulse commenced to fail. Vomited. In 10 minutes patient quite unconscious—gasping respiration and profuse vomiting. In 12 minutes the pulse was imperceptible and the respirations had ceased. Autopsy: The blood-vessels of the surface of the cord over the lumbar enlargement were engorged. The cord appeared not to have been touched by the needle and macroscopically its structure was normal. No hemorrhage observed inside the spinal theca.

Gabbett: *British Medical Journal, March 26, 1910, p. 690.*

Age 40. Elephantiasis of scrotum. Puncture between the twelfth dorsal and first lumbar vertebræ, from which the spinal fluid flowed freely. Ten cg. of novocaine and 1 mg. of strychnine hydrochloride injected. The patient sat up for 1 minute and then laid down with his head on a low pillow. In 5 minutes he was anæsthetic to the level of the nipples and in 10 minutes almost to the level of the clavicles. The patient died of respiratory failure within half an hour.

(*b*) *Where death was due to a cause other than the spinal anæsthetic.*

Bondy: *Ueber das post-operative Verhalten nach Lumbal-anæsthesia. Gyn. Rundschau, iv, 1910, p. 99.*

The patient had a systolic murmur with a striking cyanosis of the face. Five minutes after the injection before the elevation of the pelvis the patient died. Autopsy: embolus left pulmonary artery.

Hohmeier: *Hohmeier u. König. Verhandl. d. deuts. Ges. f. Chir., xxxix, 1910, p. 481. Sammelforschung über die Lumbalanæsthesie im Jahre 1909.*

In a collection of 2400 cases from 41 institutions in the year 1909, there was one patient suffering from arteriosclerosis who died 10 minutes after the injection of the spinal anæsthetic from cerebral apoplexy. There was adrenalin in the injecting fluid.

(*c*) *Other cases.*

Dönitz: *Wie vermeidet man Misserfolge bei der Lumbalanæs. Münch. med. Wchsft., 1906, p. 1338.*

The following was the first case of death caused by the anæsthetic in more than 1000 cases of lumbar anæsthesia in Bier's clinic:

Age 75. Carcinoma of penis. 0.13 g. tropacocaine diluted with 10 c.c. of spinal fluid injected between the second and third lumbar vertebræ in the sitting position. The patient was then laid flat, the anæsthetic rapidly extended to the neck, and in a few minutes the breathing and pulse stopped. Autopsy: brain and spinal cord showed nothing special. Death regarded to be due to the large dose of tropacocaine.

Veit: *Bruns Beiträge z. kl. Chir., liii, p. 751.*

Age 63. Enlarged prostate. After having been successfully subjected to novocaine spinal anæsthesia on the sixth and third previous days, there was administered a lumbar injection of 0.07 g. stovaine. Three minutes after the injection the patient suddenly became pale and the pulse and breathing stopped. Autopsy: small hemorrhage at the site of puncture within the dural sac. No macroscopic changes in the cord throughout its entire course. Veit states elsewhere that he always punctured between the second and third or the third and fourth lumbar vertebræ.

Rehn: *Ueber Rückenmarksanæs. Mitteil. a. d. Grenzgeb. der Med. u. Chir., xix, 1908–9, p. 806.*

(*a*) Quotes the results of Körte, who in 180 cases of lumbar anæsthesia had one death attributable to the anæsthetic. Woman, age 71. Incarcerated femoral hernia. Pulse 88. 0.05 g. alypin with adrenalin administered by lumbar puncture. No pelvic elevation. Forty minutes after the injection collapse and death. Autopsy: the cord was without pathological changes.

(*b*) Quotes the results of Brentano, who in 99 cases experienced one death from the anæsthetic as follows: Age 75. Irreducible umbilical hernia. 0.04 g. alypin with suprarenin injected between the second and third lumbar vertebræ. Clear fluid was first drawn. Very slight pelvic elevation. In 10 minutes the pulse and respiration became irregular and in 30 minutes the patient died. Autopsy: no cause for the sudden death.

(*c*) Reports out of 30 cases at the Charlottenberg Western Hospital, 1 death, as follows: Woman, age 79. Ileus from inoperable rectal carcinoma. Slow strong pulse. After the injection of novococaine suprarenin a small cushion was put under the hips. In 10 minutes the patient became pale and vomited and the pulse slowed. Cushion immediately removed but the patient died in another 10 minutes.

Hohmeier u. König: *Sammelforschung über die Lumbalanæsthesie im Jahre 1909. Verhandl. d. deuts. Ges. f. Chir., xxxix, 1910, p. 481.*

Out of 12 deaths in 2400 cases of lumbar anæsthesia collected from 41 institutions, due to the spinal anæsthetic, 4 were due to respiratory paralysis occurring shortly after the injection. Hohmeier says: "In such cases autopsy gives no clue to the cause of death, neither macroscopic nor microscopic changes being found."

König: *Sammelforschung über die Lumbalanæsthesie im Jahre 1909, Hohmeier u. König. Verhandl. d. deuts. Ges. f. Chir., xxxix, 1910, p. 481.*

Age 60. Intracapsular fracture of femur. Three novococaine Hochst tablets used for injection. "In 5 minutes the anæsthesia was up to the navel and in 10 minutes asphyxia supervened, and in spite of all effort to resuscitate the patient she could not be saved."

Bondy: *Ueber das post-operative Verhalten nach Lumbalanæsthesia. Gyn. Rundschau, iv, 1910, p. 99.*

(*a*.) Woman. Osteomalacia. Three days post partum. In good condition. Ten minutes after the injection stopped breathing and died. Autopsy: œdema of the brain; cystitis; pyonephritis.

(*b*) Cæsarean section. Five minutes after the injection, before raising the hips high, the patient died of respiratory paralysis. Autopsy: gave no cause for death.

Bondy had 3 deaths in 1000 cases attributable to the spinal anæsthetic.

Michelsson: *Ein Beitrag z. Lumbalanæsthesie mit stovain-Billon. Arch. f. kl. Chir., xcii, 1910, 657–724.*

Age 37. Pyloric stenosis. 0.056 g. stovaine. Also morphine 0.01 and scopolamine 0.0005. The horizontal posture was maintained. After 5 minutes there was satisfactory anæsthesia to the ensiform cartilage. On presenting the stomach there was sudden collapse and death.

Michelsson out of 400 cases of lumbar anæsthesia had 4 deaths attributable to the anæsthesia.

Sellheim: *Ueber Geschichte, Anatomie, und Technik der Rückenmarksanæsthesie. Medizinische Klinik, 1910, vi, p. 5.*

Out of 1000 cases of major gynæcological operations done under spinal anæsthesia he reports one death which could be chargeable to the anæsthetic. The case was one of proposed Cæsarean section who died before the *Kaiser schnitt* could be undertaken.

PUNCTURE BELOW THE LEVEL OF THE CONUS MEDULLARIS.

Arrangement of the Nerve-roots of the Cauda Equina.—While the distribution of the nerve-roots of the cauda equina within the arachnoid sac was found to vary considerably, their general order of arrangement with relation to one another was found to be uniform, which latter fact it can be seen would be necessarily so, in that the nerve-roots arise serially from the conus medullaris and pass downward in regular order to their fixed foramina of exit arranged in a vertical row on either side of the spinal canal. Thus the first lumbar root has the most lateral and highest origin from the conus medullaris. The root passing through the second lumbar foramen of exit takes its origin from the conus medullaris next below the first root, and so on down the whole series until from the apex of the conus the lowest sacral nerve-roots arise, which in natural order occupy the most mesial position of all the nerve-roots, either lying in close relationship with, or, in cases where there is a cleft, diverging a little from, the median sagittal plane. The mesial position of the lowest sacral nerve-roots would render them the most liable of any to injury in median lumbar puncture, traumatism to which could be offered in explanation of those cases of paralysis of the bladder and sphincters which have followed lumbar puncture.

Where the nerve-roots of the cauda equina lay together in masses they did not individually float free in the cerebrospinal fluid, but were bound closely together by delicate adhesions, which, though they could be broken apart with the use of almost no force at all, were nevertheless strong enough to hold the roots together as one solid impermeable structure. Occasionally the nerve-roots were found to float free but only in the lower part of the subarachnoid space, below where the main mass had been distributed. Thus the lower nerve-roots of the cauda equina in Dissection B (Fig. 7) were separate and free, as were also the nerve-roots from the lower lumbar region downward in one of the dissections of Type I not here illustrated.

The Sacral Leverage.—The sacrum, projecting posteriorly from its site of articulation with the lumbar portion of the spinal column, when forced downward has the action of a lever of the second order on resisting structures attached to its upper surface at a sufficient distance from the point of fulcrumage. The sacral nerve-roots may, under certain conditions, constitute such resisting structures in relation to the sacral lever. Thus when the subarachnoid space extends far enough downward into the sacral canal and is at the same time of sufficient calibre to allow those nerve-roots which are fixed to the projecting portion of the sacrum to have free play, and when at the same time these nerve-roots are not too slack (cf. Fig. 13) to furnish resistance to the downward forced sacrum, it can be seen that descent of the sacral lever will make these sacral nerve-roots taut, in effecting which, owing to the posterior projection of the sacrum, the same movement will, as well, carry the nerve-roots backward out of the lumbosacral hollow into a more posterior position (cf. Figs. 6, 7, 8, and 16).

The first sacral vertebra projects but little posteriorly and that chiefly at its base, above which latter the first sacral nerve-roots diverge to go to their lateral openings, so that these nerve-roots are attached too close to the fulcrum to be much if at all influenced by the sacral leverage. The bodies of the second and third sacral vertebræ are the ones which do project markedly backward, so that when a subarachnoid space of good calibre extends down to the base of one or the other of these vertebræ, allowing more or less opportunity for free play to those nerve-roots attached to the sacrum well behind the fulcrum, then it is that these nerve-roots, if of a length shorter than that of the lumbosacral curve in the descended position of the sacral lever, will come under the latter's influence. It was found that only extreme descent of the sacral lever could make the sacral nerve-roots taut. In the erect position of the body consequently, in which the pelvis is tilted well backward, the sacral nerves would be relaxed.

The sacral lever descends with the forward tilting of the pelvis which occurs in extreme lumbar flexion, in which position, therefore, in the presence of the conditions named, the mesially lying sacral nerve-roots will become taut and be carried posteriorly (Fig. 8). Conversely, when the pelvis is tilted backward the sacral nerve-roots are relaxed, and in extreme extension of both sacrum and lumbar column as well, all the nerve-roots of the cauda equina are thrown into a state of relaxation (Fig. 9). Therefore in lumbar puncture, it would seem of the utmost importance that the posture of election should be one in which the pelvis is not allowed to tilt forward, so as to be sure of securing relaxation of the mesially lying sacral nerve-roots, on the principle that a relaxed nerve-root is less likely to become impaled upon the point of the puncturing needle than is a tense one. Also

FIG. 3

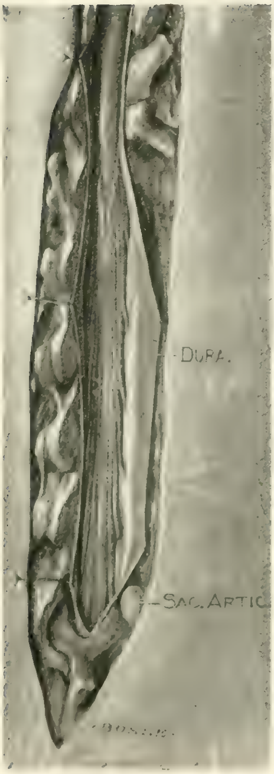


FIG. 4.

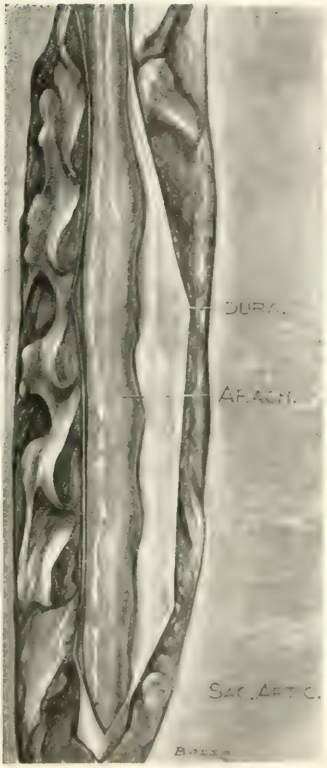


FIG. 3.—Dissection A, Type I (most frequent, 46.6 per cent.). The nerve-roots of the cauda equina, being connected together by delicate adhesions, form a flattened ribbon-like mass which occupies an anterior position in the arachnoid sac (cf. Fig. 5) and is attached on either side by the nerve-roots at their sites of exit, as well as by the adhesion of the same to the arachnoid membrane where they take a lateral position before gaining exit. In this type the positions of the sacral nerve-roots are not altered by extreme lumbar flexion (see "sacral leverage," p. 459). The delicate transparent arachnoid membrane here lay invisible, covering the nerve-roots. SAC. ARTIC., sacral articulation

FIG. 4.—Dissection A, Type I. Shows the arachnoid membrane, unseen in Fig. 3, now inflated with air. There are no nerves in relation with its posterior aspect (cf. Fig. 5), and puncture in this case could have been made safely by a direct lateral as well as by the median route through any one of the lumbar interspaces. In contrast, see Fig. 13.

when relaxed by posture, these nerve-roots if free from arachnoid attachment are capable of taking a more anterior position in the subarachnoid space than when they are taut (Figs. 9 and 11).

Downward forcing of the sacral lever produced no tension on the sacral nerve-roots in the dissections of Type I. in which the nerve-roots of the cauda equina lay bound together in a flattened mass situated anteriorly in the subarachnoid space, nor in the Dissections E (Fig. 13) or F (Fig. 14), in which latter two the nerve-roots were of too great a length to offer any resistance to the descended sacrum. Of Type I. five of the dissections were examined to investigate the reasons for the absence of the action of the sacral leverage upon the sacral nerves, and there were found the following anatomical variations to explain the condition: in three of the cases the subarachnoid space did not extend below the level of the first sacral vertebra, which, as stated, exercises practically no leverage upon the first sacral nerve-roots, and the nerve-roots below the first sacral were bound down to the sacral bodies, so that, being consequently of a length equal to that of the lumbosacral curve they moved in unison with the sacrum, and could exercise no restraint upon its descent. In each of the two remaining dissections of Type I. the subarachnoid space extended down as far as to the lower border of the body of the second sacral vertebra, but in both the nerve-roots were evidently too long to receive the pull of the descended sacrum, and in one of these the dural sheath over the second sacral vertebra was of such small calibre as practically to simulate the anatomical arrangement where the nerve-roots over this area were bound down to the sacrum.

Classification of the Caudæ Equinæ.—The caudæ equinæ of the 15 dissections have been classified according to the variation in distribution of their nerve-roots, into five different types, the points of differentiation among which are all amply noted in the legends of the illustrations.

TYPE I (Figs. 3, 4, and 5) was the most frequent, it having been found 7 times in the 15 dissections, or in 46.6 per cent

In this type the nerve-roots of the cauda equina lay massed together against the anterior wall of the arachnoid sac, and the position of the sacral nerve-roots was uninfluenced by the descent of the sacral lever. The evident reasons for the latter result have already been given (see above, "sacral-leverage"). One other dissection of the series was pre-eminently of this same type, but it presented this variation from the normal, that three aberrant nerve-roots came into relation with the posterior part of the arachnoid sac to which they were adherent. This dissection, therefore, presenting features that might lead to surgical complications similar to those that could arise in a case like that shown in Figs. 14 and 15 (Dissection F) has been classified with the latter dissection as an example of Type IV.

Fig. 5.

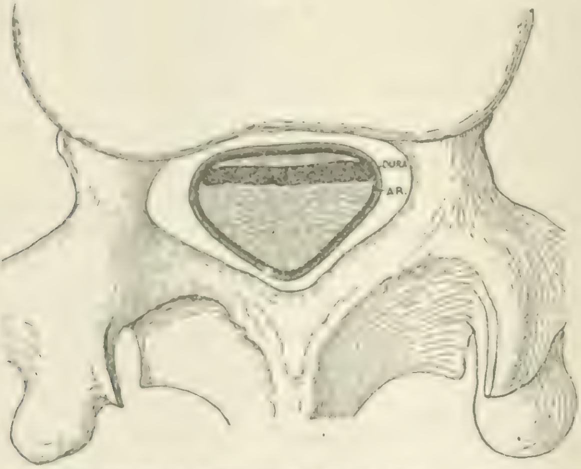


Diagram of cross section of Dissection A (Figs. 3 and 4). The nerve-roots, joined together by delicate connective tissue, lie in a flattened mass anteriorly situated in the arachnoid sac, to which latter the laterally lying nerve-roots before taking their exits are adherent.

In four of the dissections of this type observations were made as to the heights to which the arachnoid membranes extended upward from the lumbar sacculation free from adhesion to the posterior surfaces of the nerve structures, and it was found that once the posterior sacculation extended to the conus, once to two inches above the conus, and that in the other two cases the arachnoid membrane was for the most part free all the way up the cord excepting for the occasional transverse septal interruptions.

Fig. 6.

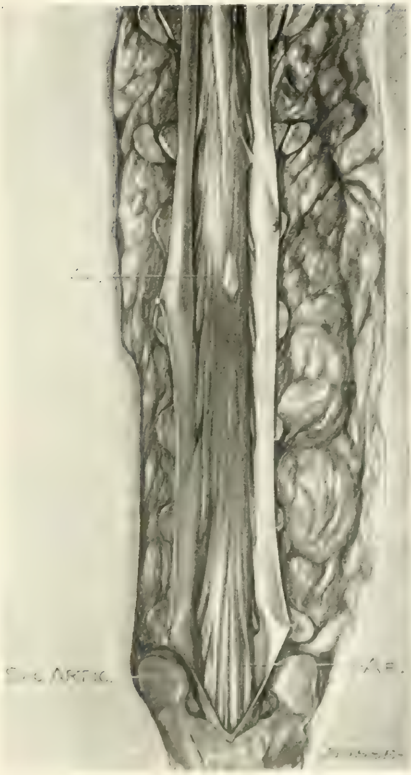


Fig. 7.

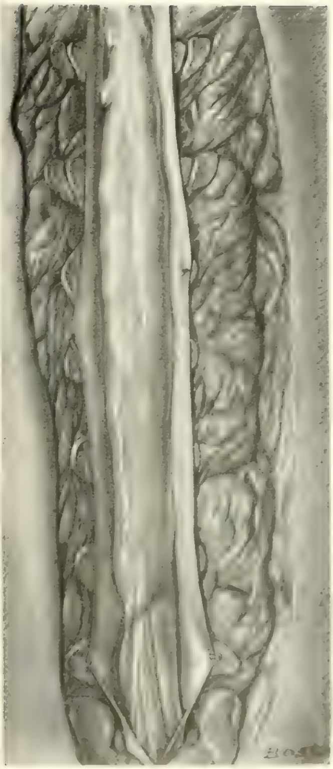


Fig. 6.—Dissection B, Type II (13.2 per cent.). This is a modification of Type I. Similar to Type I was that portion of the cauda equina above the fourth lumbar vertebra where the nerve-roots lay flat against the front of the subarachnoid space in all positions of the spine, but differing from Type I was the portion below the level of the upper edge of the fourth lumbar vertebra, where the sacral nerve-roots, by an extreme downward movement of the sacral lever, would be made taut and drawn backward so as to span the lumbosacral hollow. The subarachnoid cavity here extended downward to well over the third sacral vertebra. Ar., arachnoid membrane, which is transparent, overlying the nerve-roots. Above, this membrane was lifted by an air bubble.

Fig. 7.—Dissection B, Type II. An inflation of subarachnoid space. The air bubbles could not here so certainly have reproduced the normal relation of the sacral nerve-roots to the arachnoid membrane as could have a water distention, since the close contact between these structures as here pictured was found to have been the result of a postmortem agglutination. With the introduction of water to test the fixity of the sacral roots, and at the same time raising the sacral lever to relax the same, the latter fell away from their contact with the arachnoid membrane. The sacral nerve-roots of this dissection would become relaxed in the erect position of the body.

In this type it can be seen that a straight, forward puncture into the subarachnoid space just lateral to the median line, made below the level of the conus, would encounter no nerves, yet, for the greatest safety to the patient, the needle should nevertheless be directed toward the median line, and, as well, introduced through one of the two lower spaces only, in order to anticipate the possibility of encountering an anatomical condition such as that illustrated in Fig. 13.

Type II (Figs. 6 and 7).—Of this type there were two specimens (13.3 per cent.). This type is a modification of Type I, the distinguishing feature being that in Type II the action of the sacral leverage on the mesially lying sacral nerve-roots raises the latter posteriorly out of the lumbosacral hollow. With sacral extension, which relaxes the sacral nerve-roots, this type practically assumes the anatomical picture of Type I. In the specimen of Type II not here illustrated, the arachnoid sac terminated opposite the middle of the second sacral vertebra, and its lower half inch was narrowed around the nerve-roots, so that, being held rather closely to the projecting portion of the sacrum, the sacral nerve-roots could come but little under the influence of the sacral leverage, and consequently the extent to which they could be raised out of the lumbosacral hollow by the action of the latter was but slight. In the same dissection, opposite the fourth lumbar interspace the mesially lying nerve-roots were connected to the posterior wall of the arachnoid sac by one-quarter inch long trabeculæ, and below this level by trabeculæ diminishing in length, until, just within the sacral canal, these roots became adherent to the arachnoid sac, which finding would seem to be in evidence of a shallowness of this lower portion of the subarachnoid space. Higher, these trabeculæ became fewer and of half-inch lengths. In this case the fourth lumbar interspace, opposite to which the trabeculæ were longer than at any level below, would manifestly have been preferable to the lumbosacral interspace for performing puncture.

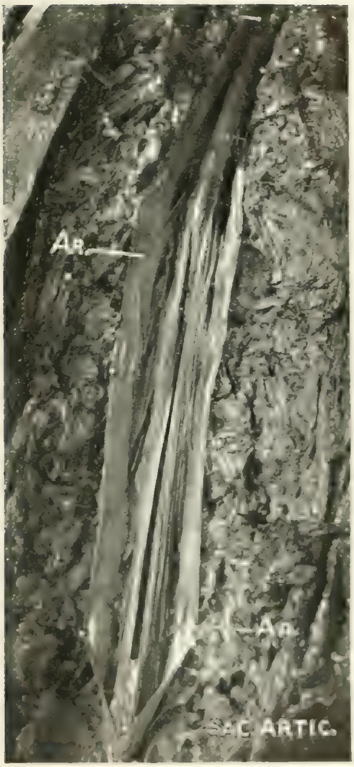
Type III (20 per cent.) (Figs. 8 to 13) included those cases in which there was a more or less high division of the cauda equina into two lateral halves. In this type the height of the bifurcation and the relations of the arachnoid membrane to the nerve-roots presented considerable variation (Dissections C, D, and E), yielding most interesting information regarding the dangers surrounding the operation of lumbar puncture. The arachnoid sac in these dissections varied from a condition of complete freedom from any adhesion posteriorly to nerve-roots (Fig. 10), to one (Fig. 13) in which it was adherent to very nearly the whole posterior surface of the nerve-roots of the cauda equina, the roots in which latter case, excepting for a sizable cleft situated mesially below the level of the upper part of the fourth lumbar vertebra, formed one solid agglutinated mass. Also in the latter dissection the arachnoid membrane was attached around nearly the entire periphery of the cleft, which it bridged over, forming a window through which alone puncture into the subarachnoid space could have been effected without having to traverse the mass of nerve-roots. This dissection was the one in the series which gave emphasis to the imperativeness of a mesial entrance of the needle into the subarachnoid space in lumbar puncture, as well as demonstrated the possible danger from puncturing at a level higher than the fourth lumbar interspace.

The results of tensing and relaxing the sacral nerve-roots in this type, by descent and elevation respectively of the sacral lever, are demonstrated in the illustrations (see " sacral leverage," p. 459). Where in this type the posterior wall of the arachnoid sac is free and the subarachnoid space ample behind the nerve-roots (Fig. 10), tension on the mesially lying nerve-roots would evidently be of no import unless the needle point penetrated to the depth at which the nerves lay. Then, it can be seen that a relaxed nerve (Figs. 9 and 11) would be less liable to become impaled than would a tensed one, its mobility enabling it to elude the needle point unless pinioned by the latter against the anterior wall of the spinal canal. The relaxed nerves, with a water content of the sac, gravitated dependently from their sites of attachment, so that the positions they would assume in the subarachnoid cavity of living man would doubtless vary with the posture of the body. In the dissection shown in Fig. 13, the sacral nerve-roots were of too great length to be made taut by the descent of the sacral lever. In this dissection it can be seen that the normal fixation of the nerve mass on either side, together with the support of the sac's walls by its fluid content, must maintain the mesial position of the cleft.

The water was introduced into the subarachnoid space in the dissection illustrated in Fig. 10, through the foramen magnum.

Type IV (13.3 per cent) (Figs. 14 and 15).—The charac-

Fig. 8.



Dissection 9 C. Type III (25 per cent.). In this type the cauda equina has a more or less high division into two lateral halves. Here the division was at the conus (cf. Figs. 12 and 13). The photograph shows the nerves made taut by the position of extreme lumbar flexion, thereby bringing into prominence the median cleft. The particular influence in making taut the mesially lying nerve-roots, which are the sacral roots, is an extreme descent of the sacral lever (see "sacral leverage," p. 459).

Fig. 9.

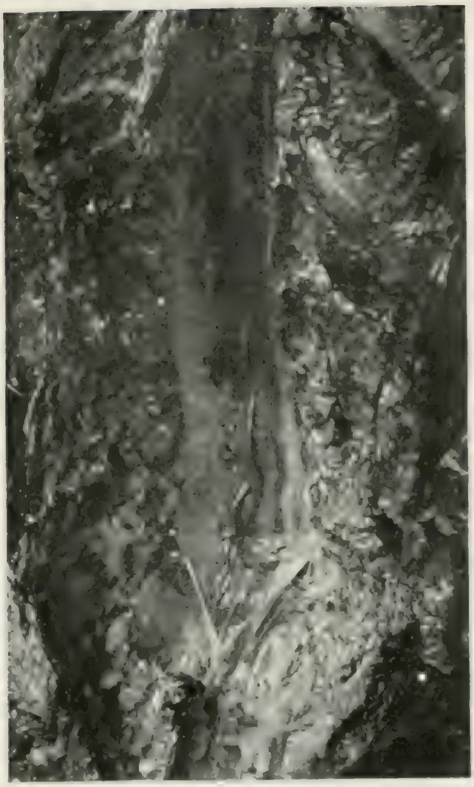


Fig. 10.

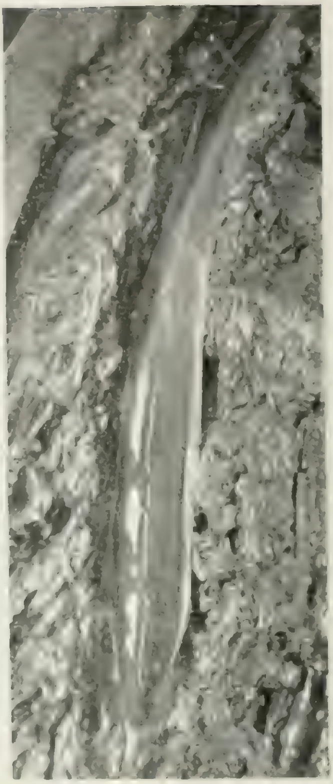
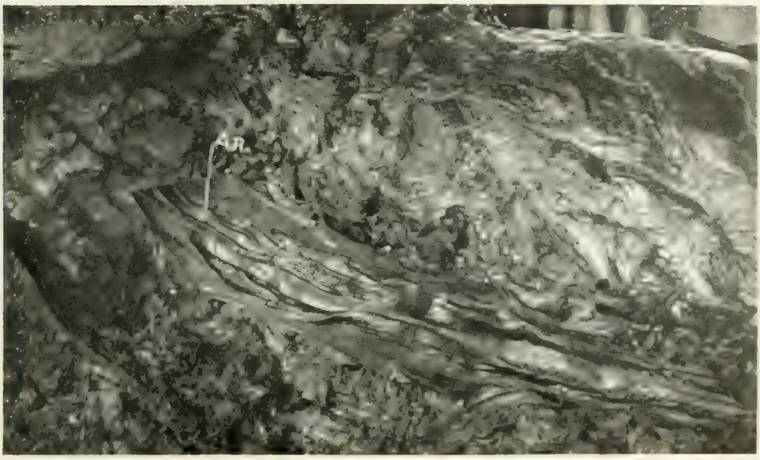


Fig. 9.—Dissection C. Type III. Photograph showing how the nerves of the cauda equina in this dissection seen in Fig. 8 to have been made tense in the position of extreme lumbar flexion, all became relaxed by the position of extreme lumbar extension. It is the relaxation more especially of the mesially lying sacral nerve-roots that comes up for consideration in lumbar puncture, and this can be gained simply by elevation of the sacral lever which is produced by a backward tilting of the pelvis.

Fig. 10.—Dissection C. Type III. Photograph of water distention of the arachnoid sac of this dissection. The position is that of extreme lumbar flexion, the same as in Fig. 8. Some of the nerves can be seen through the fluid in the lower part of the sac. The tensed nerves lay well away from the posterior surface of the arachnoid sac, which here looks to be more distended than it normally would have been with the support of the intact dura, showing the probable redundancy of this membrane. The fifth lumbar vertebra is *in situ*. A [illegible] space was continued upward behind the cord from the lumbar region to a level about three inches above the apex of the conus, above which the arachnoid membrane was adherent to the posterior surface of the cord all the way up to the upper cervical region.

Fig. 11.



Dissection C, Type III. Photograph of this dissection in lumbar extension to relax the nerve-roots, the body lying on the side with hips slightly elevated. The shoulder girdle had been removed, which gave an abnormal obliquity to the dorsal spine. The picture shows in what manner relaxed nerve-roots of the cauda equina, free from arachnoid attachment, can gravitate. The higher situated half of the cauda equina hangs dependently from its site of attachment along the line of the foramina of exit of its nerve-roots, in which position it lies against the anterior surface of the arachnoid sac. The lower situated half sags into the dependent lateral curve of the arachnoid sac.

Fig. 12.

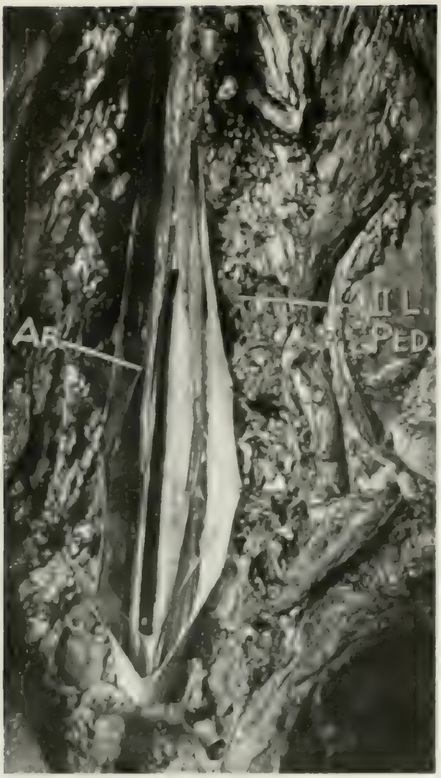


Fig. 13.

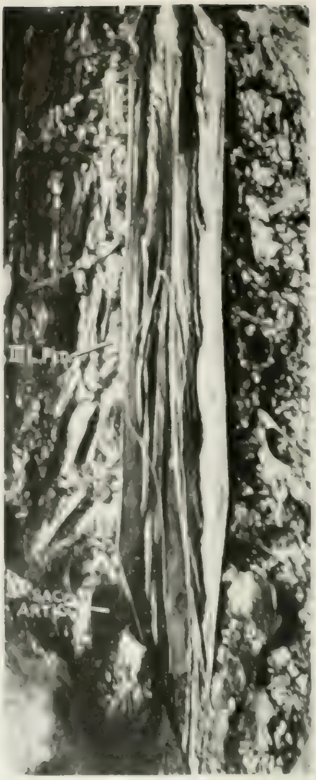


Fig. 12.—Dissection D. Type III. [illegible] of the cauda equina [illegible] lumbar interspace, [illegible] the nerve masses [illegible] this level. As indicated, the lower level of [illegible] of the posterior wall of the arachnoid sac to the nerve-roots, which was also the upper limit of the original cleft. Above this level, with water distention of the subarachnoid space, the nerve-roots were lifted posteriorly by the fluid, but below, the now free arachnoid sac was lifted by the water well behind the nerves. Here, puncture as low as between the second and third lumbar vertebræ would have passed through the mass of nerve-roots, but in the lower three interarcual spaces puncture could have been safely made. The position is that of extreme lumbar flexion, which here tensed the sacral nerve-roots, raising them [illegible]. With [illegible] slightly flexed, the lateral halves of the cauda [illegible] anterior wall of the arachnoid sac. The arachnoid membrane was [illegible] surface of the spinal cord practically [illegible] II L. Ped., second lumbar pedicle.

Fig. 13.—Dissection E. Type III. [illegible] noid sac, excepting that [illegible] rent everywhere to the [illegible]

teristic feature of this type was a peripheral distribution of the nerve-roots of the cauda equina around the walls of the arachnoid sac, with adhesion of the roots to the latter. Besides the Dissection F illustrated in Figs. 14 and 15, another of the dissections was classified as one of this type, which had pre-eminently the anatomical characteristics of Type I, but presented this variation therefrom which was characteristic of Type IV, that three aberrant nerves came into relation with the posterior part of the arachnoid membrane, to which they were adherent. Two of these nerves, running parallel and near together, formed loops bowing backward to near the median line opposite the third lumbar vertebra, and the other, a fine nerve filament, passed around posteriorly from the front opposite the fourth lumbar vertebra to a position near the median line. An effort to prick these nerves with a hatpin having not too sharp a point, directed against them from without the dura after the membranes had been opened, resulted in the slipping of the nerves out of the way, the same as occurred when this test was practised on the nerve-roots of Dissection F (see legend, Fig. 15).

Fig. 15.

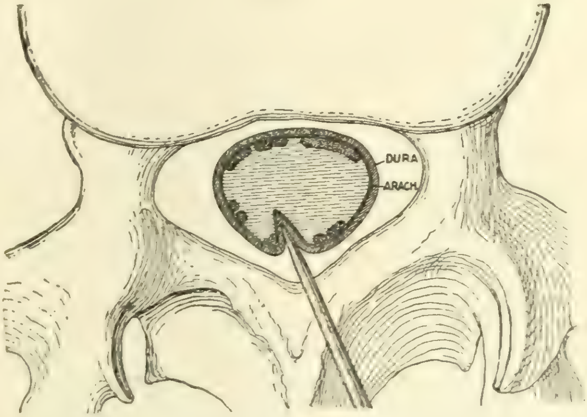


Diagram of cross section of Dissection F (Fig. 14, Type IV) at level of fourth lumbar interspace. It indicates the result of an effort made to injure these nerve-roots with a short hat pin which had not a sharply pricking point, directed against them from without the dura, subsequent to opening the spinal theca. When the dural flap, held by forceps, was allowed to yield a little before the pressure of the puncturing agent, repeatedly the latter would drive before it a wedge of dura, cleaving therewith a path between the nerve-roots, which would recede on either side of the wedge to places of safety before the membrane gave way. Only when the dural flap was drawn very taut by the holding forceps did it seem possible for the hat pin to prick the underlying nerve, which it would then carry inward on its point.

The picking up in the line of puncture of a nerve-root attached to the arachnoid membrane, such as those found in the dissections of this type, on the extremity of a needle with a sharply pricking point might help explain those cases in which, on subarachnoid puncture, the flow of cerebrospinal fluid through the needle comes slowly in drops from evident partial obstruction of its calibre. The practical experience in the case of these dissections with the hatpin (see legend, Fig. 15) would argue in favor of the use of a puncturing needle without a sharply pricking point. The sacral nerve-roots in Dissection F were not made taut by the descent of the sacral lever.

TYPE V (Figs. 16 and 17).—The cauda equina here consisted of a flattened central stalk from which the nerve-roots, bound together in ribbon-like bands, diverged. The nerve mass arched transversely backward within the subarachnoid space. It can be seen in this dissection how it would be of the utmost importance to relax the sacral nerve bands before introducing a needle into the subarachnoid space. With the mesially lying nerve bands relaxed, from a knowledge of the presence of trabeculæ between the posterior wall of the arachnoid sac and the nerve bands underlying it, of a length of about one-quarter inch, it can be estimated that a needle could pass within the subarachnoid space for a depth equal to this figure before nerve structure would be touched. With deeper penetration, a needle having a sharply pricking point would then probably pick up the relaxed nerve bundle, thereby partially obstructing its calibre, while a needle having a dulled point would be more likely to push the nerve structure before it or pass around the side of the same. With, on the other hand, the mesially lying nerve bands made taut by forcing the sacral lever downward, it can readily be seen that it is quite possible for these bands to be drawn backward closely against the arachnoid membrane, in which event they would almost surely be pierced by the puncturing needle. Or supposing that, even in their tensed position, the full fluid space behind these bands should be still preserved, they would nevertheless be very liable to receive injury, from the fact of their being held rigidly, without any opportunity to yield or swerve.

The impalement of nerve structure on the point of the puncturing needle, in a type of cauda equina of this sort, might also be held accountable for slow dropping of the cerebrospinal fluid, as well as in the case of Type IV.

Fig. 14.

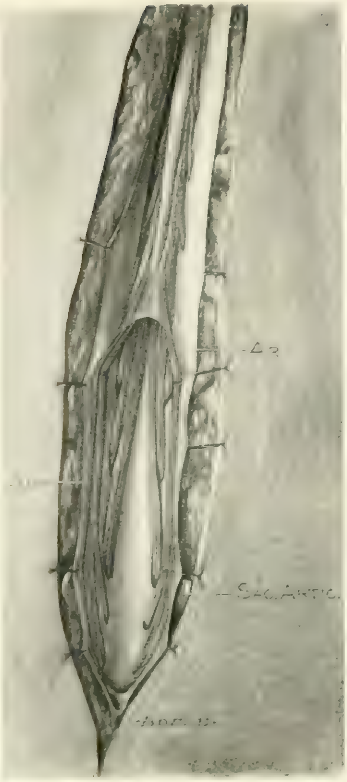


Fig. 16.

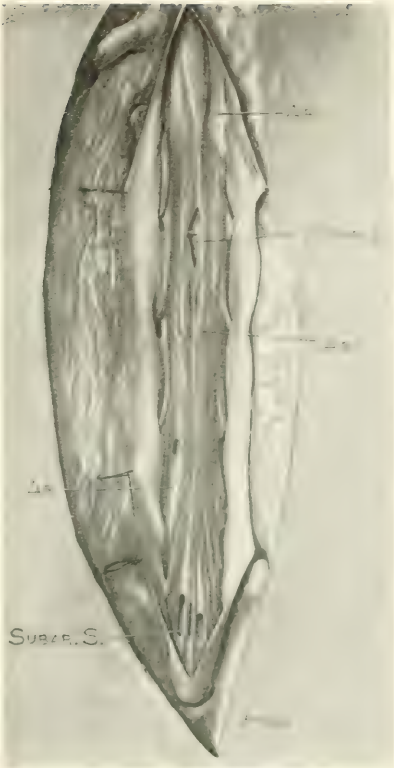
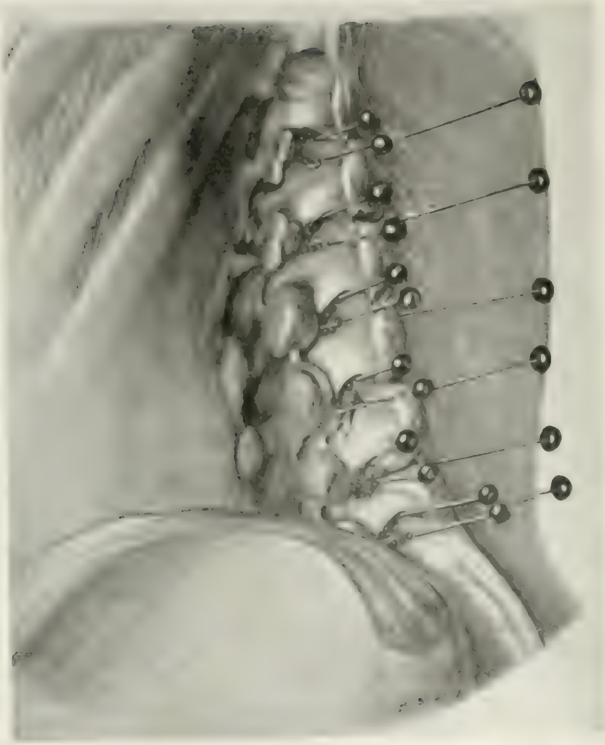


Fig. 14.—Dissection F, Type IV (6.6 per cent.) (cf. Fig. 15). The nerve-roots of the cauda equina were here separate and disposed peripherally within the subarachnoid space, each nerve being attached by delicate adhesions to the arachnoid membrane throughout its course. As soon as the subarachnoid space was laid open, the laterally and posteriorly situated roots were tacked with threads to the dura, in order to maintain their normal relationships to the spinal theca when the latter's flaps were spread widely apart. The sacral nerve-roots were not here made taut by the descent of the sacral lever, though the subarachnoid space reached to the lower border of the third sacral vertebra. This was one of the three out of eleven dissections, in which a subarachnoid space was found behind the cord all the way up into the cervical region.

Fig. 16.—Dissection G, Type V (6.6 per cent.) (cf. Fig. 17). The nerve-roots diverged in flattened ribbon-like bands from a central stalk. The nerve structure of the cauda equina [illegible] transversely backward into the posterior [illegible] of the subarachnoid [illegible] a greater area of the latter space was situated in front of the nerve-[illegible]. The artificially made cleft in the central stalk, held open by a stick, [illegible] open space in front of the nerve structure. [illegible] by reference to the diagram of a [illegible] (Fig. 17). The mesially lying sacral nerve-roots were taut in extr[illegible] relaxed in the erect position of the body. [illegible] lower border of the third sacral vertebra. This was one of the three [illegible] the cervical region.

Fig. 1[illegible].



View of posterior aspect of the lumbar portion of a [illegible] seen at an angle of about 45° with the median sagittal plane. The [illegible] in the almost vertical position. The bony limits of the [illegible] spaces are [illegible] by the pins. *The small black pin heads* outline the extents laterally of these spaces. The third lumbar interspace shows considerable bony encroachment. The lumbosacral interspace is the largest of any, is nearest the skin surface, and its [illegible] offers less resistance to a needle than do the others. [illegible] were introduced as nearly straight forward as possible at the upper and lower limits of these spaces [illegible] the levels of these deep points with relation to the [illegible] *large-headed* [illegible] ligaments close to the upper margins [illegible] interval, these pins protrude at the levels of the lower of the two [illegible] straight forward in each interspace. In the [illegible] pin lies a little higher. A large [illegible] process of the [illegible] lumbar vertebra. [illegible] and therefore become, when [illegible]

Site of Greatest Safety for Performing Lumbar Puncture. —The one site at which lumbar puncture of the subarachnoid space could have been made without liability of injuring the nerve-roots in all of the fifteen dissections, using a needle not too sharply pointed (Figs. 15 and 17) and relaxing the mesially lying nerve-roots by sacral extension, was mesially in the interval between the fourth and fifth lumbar vertebræ (see Fig. 13). A puncture mesially in the lumbosacral space could probably have been done with equal safety in all the dissections, but it must be regarded as second in order of desirability, since at this level there was a greater tendency for the nerve-roots to become adherent to the posterior wall of the arachnoid sac, as well as for the subarachnoid space to become shallower. In one dissection the subarachnoid space terminated at the upper border of the first sacral vertebra.

FIG. 17.

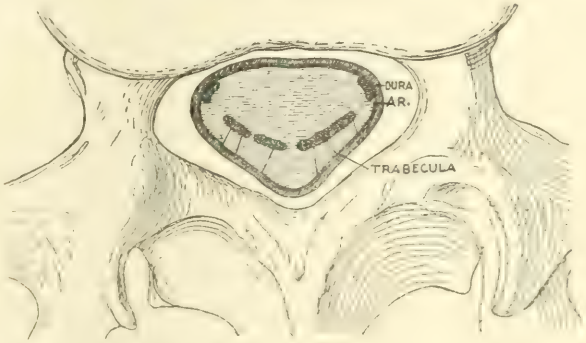


Diagram of cross section of Dissection G (Fig. 16, Type V) opposite the fourth lumbar interspace. Below the lower border of the fifth lumbar vertebra all the nerve-roots were adherent to the arachnoid. Above this level the arachnoid was firmly adherent over the posterior surfaces of the laterally situated nerve-roots of the cauda equina, while mesially it lay loosely over the posterior surface of the nerve structures, to which it was connected by delicate trabeculæ from about one-eighth to one-quarter inch in length, the shorter trabeculæ occupying the more lateral positions. Fluid tests were not made, but it would seem likely that in the presence of a fluid content within the arachnoid sac, *with the nerves relaxed by posture*, there would have been mesially in the posterior part of the sac a depth of about one-quarter of an inch of fluid which could be traversed by the puncturing needle before nerve structure would be touched.

THE TECHNIC OF LUMBAR PUNCTURE.

Quincke[7] early urged the importance of puncture of the spinal subarachnoid space only below the level of the conus medullaris, and, as well, of making the puncture in the median line, to which latter procedure he made an exception in the case of muscular males, who have particularly tough median line structures, on whom he advised instead a puncture entering at a slightly lateral point and aimed at the posterior median line of the spinal theca. Dönitz,[8] after having produced half-sided anæsthesia in three instances consequent upon the injection of an anæsthetic solution into the lateral portion of the subarachnoid cavity with the patient in the sitting position, insisted upon the necessity of median puncture, so that the needle point should enter a median cleft between the two halves of the cauda equina described by Quincke, and thus avoid the laterally lying nerve-roots. Quincke [9] employed the lateral position for puncture in order that the elastic tension in the arachnoid sac could be measured apart from the influence of the hydrostatic pressure of the column of fluid that would be brought into play by the erect position. He contended that the subarachnoid pressure should not be lowered below the normal. He says (*Deuts. Kl.,* vi) that Krönig found that in adults the lumbar pressure in the horizontal dorsal position was 125 mm. and in the sitting position 410 mm. Hosemann,[10] of Rostock, measures the subarachnoid pressure by Quincke's method, in spinal anæsthesia, reducing it if raised, to 120 mm., or raising it if reduced, which is the condition more often found, by giving saline solution subcutaneously or by rectum. He thus controls the sequel headache. Müller [11] a year later reports a continuation of this practice with satisfaction at the Rostock Klinik.

Michelsson estimates roughly the subarachnoid pressure from the force of the stream through the needle, and withdraws more or less of the cerebrospinal fluid accordingly. Quincke [12] refers to Ossipow's experiments on dogs to demonstrate the effect on the circulation of the central nervous system of the withdrawal of the cerebrospinal fluid. He says: "The rather rapid removal of the fluid resulted not only in a hyperæmia of the cortex and substance of the brain and cord, but also in small hemorrhages, and, where the animals were allowed to live, in degeneration of the ganglion cells of the cord." H. Tyrrell Gray [13] who, in spinal anæsthesia practises withdrawal of the cerebrospinal fluid until its flow is obviously influenced by the respiratory movements, writes: "The withdrawal of a considerable quantity of cerebrospinal fluid has no discernible constitutional effect on the patient."

The writer is inclined to believe, in theory, that the greater the reduction in the amount of the cerebrospinal fluid in the subarachnoid space, excepting to a point of complete depletion, the greater will be the distance through which the fluid that remains will shift cranialward should the head be lowered. Gray is very careful to keep the head elevated on account of using an anæsthetizing solution of a heavy specific gravity.

Dönitz employed the sitting posture in order that the needle could be driven forward more accurately in the median line. Both Quincke and Dönitz employed the position of extreme lumbar flexion. Sellheim [14] explained that the tension produced by forward bending of the body brought into prominence the median sagittal cleft, between the two halves of the cauda equina. Quincke advised puncture below the second lumbar vertebra to avoid the conus medullaris. Bier [15] punctured between the second and third, or first and second lumbar vertebræ. Colombani [16] preferred the fourth lumbar interspace.

The Needle.—Strauss [17] has said that to penetrate the median interspinous ligamentous structures the point of the puncturing needle must be as sharp as possible. He first used Quincke's needle and then Bier's. Sellheim [18] advocated the use of a needle as blunt as possible so as to preserve the sense of touch. He says that the angle of obliquity of the long axis of the opening in the needle point with the shaft should be about 50°, and that the margin of the opening should be rounded off. The needle should be provided with an obturator which exactly fits the point.

The writer is of the opinion that a moderately blunt needle, as well as giving greater perception to the sense of touch, is less likely to cause injury to any nerve-roots it may meet or to become obstructed by such roots than is a sharply pointed one (see Fig. 15, and descriptions in the text of Types IV and V). Bier recommended that the point of the needle should be short to ensure its complete entrance within the subarachnoid space, since a long point, if arrested when but partially passed within the spinal theca, might both tap the subarachnoid space and at the same time be the cause of a peridural spilling of the injected fluid.

Slamjer[19] advises that the needle should have a short oblique point for the same reason. Barker[20] avoided this difficulty by threading through his needle a canula which projected beyond the point. The needles should be made of platinum or pure nickel, neither of which metals rust, the importance of which lies in the fact that the drugs used for spinal anæsthesia are decomposed by an alkali, and therefore the implements with which they come in contact must be boiled in plain water. The diameter generally recommended for the needles is about 1 mm. Slamjer suggests that a needle of too great a diameter may make so large a puncture in the spinal membranes as to allow a reflux of cerebrospinal fluid through it after the needle has been withdrawn. Sellheim describes a manner of holding a relatively blunt needle when puncturing in the median line, in a way to employ the sense of touch, as follows: "The puncturing needle, after penetration of the skin and the superficial ligamentous structures, is strongly grasped by the index finger and thumb of each hand, while the other fingers find as many points of support as possible on the back, on either side of the site of puncture. In this position a deep touch perception can be most delicately observed by the play of the fingers." He could thus determine by the sense of touch when the point of the needle had passed the resistance of the ligamentous structures. He estimated the distance between the ligamentum subflavum and the cerebrospinal fluid in corpulent people to be about 1 cm.

Hemorrhage.—Hemorrhage arising from spinal puncture may be either epidural or subdural. If pure blood flows out through the needle, the source of the hemorrhage is epidural. If blood-tinged cerebrospinal fluid is drawn, the source is subdural (Quincke). Since the posterior epidural venous arcades underlie the bony arches of the lumbar spine (p. 451), and since the mesially lying anterior epidural venous plexuses occupy only the transverse hollows of the posterior surfaces of the lumbar vertebræ (p. 451), there are therefore normally no sizable epidural veins in the line of a straight, forward puncture, which is directed toward an intervertebral disk, and the liability of hemorrhage occurring from this source is very slight. Borschardt[21] reports a case, however, of a 60-year-old man with an enlarged prostate, in which after an injection of 0.06 g. tropacocaine, followed by high pelvic elevation, collapse and death supervened. The autopsy showed an epidural hemorrhage which with the high pelvic elevation had flowed upward to the second or third cervical vertebra, while the sacral canal contained no blood. Borschardt does not attribute the cause of death any more to the hemorrhage than to the tropacocaine and high pelvic elevation. Bolton[22] has questioned whether it would be possible for the cord to be compressed at all by bleeding into the epidural tissue.

Concerning subdural hemorrhage, in König's case of paraplegia (p. 481), the subarachnoid injection of stovaine was made directly upon having drawn through the needle cerebrospinal fluid colored light red, regarding the impropriety of having done which, König, in reporting the case, made the following reflection: " We must regard as an absolute rule the principle already laid down by Dönitz, though for somewhat different motives, to inject the anæsthetic only when clear liquor is drawn." Bier says in this regard: " If blood drops forth and is not soon succeeded by clear liquor, then the needle should be withdrawn and reintroduced in another intervertebral space." Michelsson says: " A fresh puncture seems to us necessary only in those cases where the cerebrospinal fluid is bloody and does not quickly clear up. In the cases where we injected nevertheless, we most always have seen total failures." He regarded that the blood admixture with cerebrospinal fluid neutralized the effect of stovaine.

Slow Dropping of the Cerebrospinal Fluid from the Punc-

turing Needle.—In seeking for the cause of this manifestation among the anatomical findings of this work, the evidence has been in favor of attributing a slow dropping of the cerebrospinal fluid through the needle to the impalement of a nerve on the point of the latter (see text Types IV and V, pp. 465 and 466) which would manifestly be more likely to happen with the use of a needle having a sharply pricking point and in the presence of tensed nerve-roots lying in the line of puncture, than with a needle having a relatively blunt point and with the mesially lying nerve-roots of the cauda equina relaxed. Bier says on this subject: "The anæsthetic should never be injected before the liquor flows out in quickly following drops. The neglect of this rule causes most of the so-called 'failures.' The needle should be turned with very slow forward pushing or backward drawing until the liquor flows right."

The Cardinal Principles.—The writer would enumerate these as follows:

1. The posture of the patient should be one embodying pelvic extension (elevation of the sacral lever), for the purpose of assuring relaxation of the mesially lying sacral nerve-roots of the cauda equina, that they may the better elude the needle-point.
2. Puncture should be made only in the fourth lumbar (preferably) or the lumbosacral interspace.
3. The point of the needle should be aimed at the posterior median line of the spinal theca (Quincke, Dönitz, Gerstenberg and Hein, Sellheim, and Fig. 13).
4. The point of the needle should be short to ensure its complete entrance within the subarachnoid space (Bier), and relatively blunt both for adding delicacy to the sense of touch (Sellheim), as well as to reduce to a minimum the liability of impalement upon it of the nerve-roots (see text Types IV and V, pp. 465 and 466).

The question would now arise, as to what plan of technic would best inculcate these principles.

The Posture (sacral elevation).—In the erect position of the body the pelvis is tilted sufficiently backward to relax the sacral nerve-roots, and also the amount of space between the spinous processes (Fig. 18), though less than with acute lumbar flexion, is sufficient for the performance of median lumbar puncture. In forced lumbar extension the spinous processes crowd closely together, which movement, when suddenly made by the patient during median lumbar puncture, may cause breaking of the needle.

In the lateral position, pelvic extension can be maintained by straightening the dependent thigh, and then, in order to keep the balance, the leg and thigh of the opposite side can be flexed until the foot of this side rests upon the knee of the dependent extremity.

The Choice of the Route of Puncture.—In this connection there arises the question of the necessity for the use of a needle with a relatively blunt point for the purpose of lessening the danger of injury to the nerve-roots, the fact for consideration being that a needle of this description can be passed through the intercepting structures of the lateral route with a delicacy of touch which is impossible by the median route. So that, if the lateral route with the use of a relatively blunt needle can be shown to at least be as safe as the median with the use perhaps of a sharper needle, it would naturally become the route of choice.

Certain of the anatomical facts here demonstrated would seem to throw some light upon this problem. The three dissections E, F, and G (Figs. 13 to 17) were the only ones of this series in which the route of puncture or shape of the needle point could have had any bearing on injury to the nerve-roots. In every one of the other 12 dissections, the anatomy was such that, with sacral lever raised, the subarachnoid space could have been tapped through any one of the three lower interarcual spaces, without danger of injuring any of the nerve-roots by either lateral or median route, and with a sharply pointed needle as well as with a blunted one.

The original operation of median lumbar puncture proposed by Quincke was based upon the proposition that the cauda equina invariably divided at the conus into two lateral halves, having a cleft between them from 2–5 mm. in breadth, through which interval alone the cerebrospinal fluid must be drawn. Dönitz and Sellheim in their essays on technic reiterated Quincke's argument for median puncture.

Out of the whole series of 15 dissections here presented, Dissection E (Fig. 13) was the only one in which the cerebrospinal fluid would have had to have been drawn from between the two halves of the cauda equina. The cleft in this dissection did not visibly spread on cutting through the arachnoid window attached to its two sides, so that the illustration gives a good idea of the available space there would have been here for puncture. In this dissection an exact median puncture through the fourth lumbar interspace would have been the ideal operation. Yet in seeking to establish one technic to best meet all anatomical variations, provided in all other complicating arrangements of the nerve-roots (Dissections F and G) it can be shown to be desirable to employ a relatively blunt needle and a lateral route of puncture, it would seem to be the question for consideration in the case of Dissection E, whether for it too the blunted needle and lateral route might not be utilized at least as a very good compromise in place of median puncture if not as an equally good procedure. (See *mesial puncture of the spinal theca by a lateral route*, p. 475.)

The other two dissections, F (Figs. 14 and 15) and G (Figs. 16 and 17), for special consideration, are the ones which argue strongly for the use of the relatively blunt needle, though for different reasons, Dissection F in order that the needle may be one that can drive a wedge of dura between the nerve-roots before it penetrates, and Dissection G in order that the needle may be one that the posteriorly lying nerve bands, relaxed by elevation of the sacral lever, can best elude. In neither of these dissections does the importance of a direct forward median puncture for entrance into the subarachnoid space seem to be demonstrated, and on the other hand there would seem to be every reason for using as blunt a needle as possible, introduced with the utmost delicacy of touch, which conditions are best fulfilled by the lateral route.

Anatomy of Median Lumbar Puncture.—A tubercle projects downward from the lower margin of a lumbar spinous process close to its posterior extremity, so that in performing median puncture the needle should be made to follow as closely as possible the upper border of the lower spinous process of the interspace through which it is passed, to avoid encountering the tubercle.

In median lumbar puncture the needle is liable to some little deflection from the exact median plane. The writer planted two hat pins straight forward in the spinal canal, one introduced in the interspinous interval in a line which was thought to occupy the exact median plane, and the other, one-third inch lateral to the first. On dissecting out the points, they were found to have entered the spinal theca close together a little lateral to the middle line. Gerstenberg and Hein say that a little deviation of the needle from the median line makes no difference.

The supraspinous ligament measures about one-quarter inch across, while the interspinous ligament at its middle portion is only about one-twelfth inch thick. Quincke estimated the depth of lumbar puncture to be usually from 4 to 6 cm.; in large muscular men from 7 to 8 cm.; and in fat people even to 10 cm.

The depth of puncture in the lumbosacral interspace is perceptibly shallower than is that in the lumbar interspaces above.

Mesial Puncture of the Lumbar Spinal Theca by a Lateral Route.—H. Tyrrell Gray[23] practises lateral puncture exclusively. He says: “These dangers” (those of lateral puncture) “I am convinced have been greatly exaggerated.” He states that in some hundreds of lumbar punctures the nerves had been touched by the needle or canula on only three occasions. Gray, from a point just lateral to his finger-tip placed on the interspinous interval in the median line of the back, directs the needle very slightly upward and inward. “The needle can be felt in its course to penetrate two resistances: (1) the ligamentum subflavum, and (2) the dura mater." The writer has employed the same deep guides for a number of years in a limited experience with lateral lumbar puncture, using a needle without a sharply pricking point, since in this way he had found that he could be guided by the sense of touch. Slamjer, in reporting 2700 cases of lumbar anæsthesia with tropacocaine, says: "The puncture was either lateral or median without our having seen any remarkable difference resulting."

The ligamentum subflavum in the lumbosacral interspace is thinner than are those in the lumbar spaces above, and consequently offers a considerably less resistance to the penetrating needle.

In fat people, in whom the spinous processes cannot be differentiated by palpation through the skin, *the lumbar interspinous interval can be located* in two ways, one by prodding with a needle from a slightly lateral position across the median line structures, and the other by touching with the needle the lower border of a lamina near where it joins the spinous process. The latter site is recognized by its superficial location, three-fourths to one inch beneath the skin surface, the conformation of a lumbar lamina exhibiting a rather prominent backward slope from above downward, so that its lower border overhangs considerably the upper margin of the lamina immediately below it (Fig. 18). Consequently if the puncturing needle, introduced close to the median line structures, strikes bone thus superficially, the point of contact must be offered by this prominent lower border of the lamina, which indicates that the course of the needle is just a little above the level of an interarcual space.

In order to as accurately as possible penetrate the posterior median line of the spinal theca with a needle introduced through a lateral route, the point of the needle must first be made to touch some deep guide from which, as a point of ultimate departure, it can take a short and direct course to its final destination. With the attempt to direct the needle from a point of slightly lateral entrance on the skin surface in one straight line to the posterior mesial area of the spinal theca, the needle point may very easily get outside of the limits of the interarcual space. Thus it was found by this method that the point could pierce the interspinous ligament and impinge on the lamina of the opposite side, or that it could strike the under margin of the spinous process. The deep guide in the procedure here proposed is the ligamentum subflavum or the bone adjacent to it, which is met by the needle when passed straight forward through the erector spinæ muscle, parallel with and closely adjacent to the interspinous ligament. The close relationship of the course of the needle to the latter structure is advisable, in order that the needle can be made to enter the posterior mesial area of the theca with as little inclination from the median sagittal plane as possible. The point of entrance selected was therefore one quarter inch from the median line of the back, and the needle, taking thence a straight forward course, should consequently reach the level of the interarcual space also one quarter inch from the median sagittal plane. A short longitudinal stab wound of the skin should be made at the site of entrance of the needle. This incision is necessary for the entrance of a relatively blunt needle, while at the same time it does away with the binding influence of the skin on the shaft of the needle, as well as avoids the danger of contamination of the needle by the bacteria of the skin.

The resistance of the interarcual area is encountered at a depth of from one and one-half to two inches beneath the skin, excepting opposite the lumbosacral interspace where the depth is less. After the needle has encountered the resistance of the spinal column (usually that of the ligamentum subflavum), it should not be attempted to push the instrument straight through into the subarachnoid space, but instead, before trying to complete its introduction, it should first be slightly withdrawn until its point lies free in the muscle, and then from this latter position it should be given its direction toward the posterior median line of the spinal theca, which is done by inclining it at an angle of about 5 degrees with the median sagittal plane. The needle will then usually pass unobstructedly through the firm structure of the ligamentum subflavum to penetrate the spinal theca. Sometimes, however, the angle must be increased to about 7 degrees to get over a lateral bony obstruction. Or, if this slightly increased slant of the needle be of no avail to elude the bony opposition, then the latter is probably due to a high projection of the upper margin of the spinous process, to get above which, the point of the needle should be gradually worked upward, maintaining all the time the inward inclination of 5 degrees, until finally the point finds entrance beneath the middle of the upper bony arch of the space. An upward slant of the needle of from 5 to 10 degrees may be necessary.

Certain advantages of the lateral route over the median can be summarized as follows:

1. The needle can be guided more by the sense of touch.
2. There can be used a needle with a less sharp point, which both aids the sense of touch and is less liable to cause nerve injury.
3. With a correct technic, the posterior mesial area of the spinal theca can be entered in almost as straight forward a direction as is possible by the median route, and apparently about as near the median line.
4. There is no danger of breaking the needle.
5. The operation is capable of performance, if desired, in the position of extreme lumbar extension.

PARALYTIC SEQUELS OF LUMBAR PUNCTURE AND THE LUMBAR INJECTION OF A SPINAL ANÆSTHETIC.

But one reference to a paralytic sequel following lumbar puncture *per se,* was found in literature. Slamjer,[24] speaking of permanent nerve paralyses following spinal anæsthesia, says: "Quincke saw such a paralysis occur as a result of simple lumbar puncture, the reason for which he attributed to a hemorrhage in the nerve substance." There were found, however, a number of reported cases having paralytic sequels following the lumbar injection of a spinal anæsthetic, a brief consideration of which it was thought might be illuminating to the subject matter of this paper.

These paralyses following the lumbar injection of a spinal anæsthetic became apparent either closely consecutive to the recovery of the patient from the effects of the anæsthesia, or else later after an interval of complete restoration of function to the patient. They are regarded to be due either to trauma inflicted on the nerve structures by the puncturing needle, or to some irritative action of the solution injected. It can be seen that paralyses attributable to the former cause must be limited to the lower half of the body, and that their onset, as in the case of any severe nerve injury, ought to be immediate. The late occurrence of a paralysis would seem to be at total variance with a traumatic origin, and might consequently be regarded as characteristic of an irritation by the anæsthetizing drug. In support of the latter proposition is the fact that paralyses of the upper extremity and more frequently of the eye muscles, following the lumbar injection of a spinal anæsthetic, which could by no possible logic be attributable to the traumatism of a lumbar needle puncture, are characterized by a late onset. These late occurring paralyses are sometimes permanent.

Owing to an almost general obedience to Quincke's early injunction to enter the puncturing needle below the conus medullaris, which could then only encounter individual nerve-roots, the cases of paraplegia following lumbar anæsthesia attributable to the needle puncture have been few. On the other hand isolated paralyses of the lower half of the body following lumbar anæsthesia, which might be due to injury of individual nerve-roots of the cauda equina, are more frequent. The latter sequels seem to affect exclusively the bladder and anus and the area of distribution of the peroneal nerve. That the nerve-roots of supply to the bladder and anus, which are the third and fourth sacral, should be ones of selection for injury by the needle it is easy to understand, since they occupy the most mesial position of all the nerve-roots of the cauda equina, and consequently, excepting where a mesial cleft exists, lie in line with a median puncture.

As regards the liability of causing injury to an agglutinated mass of nerve-roots by puncturing them with a needle, Dönitz's [25] three cases of half-sided anæsthesia, and that of Trautenroth,[26] resulting from the injection of the anæsthetic solution laterally within the spinal theca, are instructive. Dönitz employed the sitting position, so that any possible influence of gravity to retain the injected fluid all on one side could be eliminated. No ill results were recorded. Trautenroth, with the patient in the left lateral position, produced a right-sided anæsthesia, so gravity in his case too could have played no part. He introduced the needle to the left of the median line and aimed it obliquely toward the median line. The patient experienced a severe pain in the right leg, whereupon the operator, without withdrawing liquor, injected 0.06 g. tropacocaine with resulting anæsthesia of the right lower extremity only. The other side of the subarachnoid space was then injected with 0.045 tropacocaine. Headache was the only sequel. Oelsner and Kroner [27] have published a case, in which, during the operation for spinal anæsthesia, there was pain in the right leg as if a nerve of the cauda equina had been struck. The pain disappeared after one to two minutes. There was no change in the pulse or respiration, and there were no serious complications or sequels.

The comparative infrequency with which paralysis has followed lumbar puncture, in the face of the indisputable anatomical evidence here presented that nerve-roots may so frequently be in relation with the posterior arachnoid wall opposite the second and third lumbar interspaces, would seem to be in evidence that the trauma of a needle penetrating nerve-roots of the cauda equina is generally well borne. This observation, however, should not be construed as furnishing a reason why the utmost punctiliousness should not be observed to avoid the nerve-roots in practising lumbar puncture.

I. Whole Lower Extremity Paralyses Immediately Following Spinal Anæsthesia.

1. TRAUTENROTH: *Ein Fall von schwerer Stovainvergiftung nach Lumbalanæsthesie nebst Bemerkungen über halbseitige Anæsthesien, Deuts. med. Wochenschrift, 1906, p. 7. Forceps extraction.*

Patient on left side. Point of entrance of needle between the first and second lumbar vertebræ about 1 cm. to left of median line. No cerebrospinal fluid came through the needle, but nevertheless half a Pravaz syringeful of 1:1000 adrenalin solution was injected. With a new puncture between the second and third lumbar vertebræ, cerebrospinal fluid was drawn; 1 in 1000 adrenalin solution was now injected, followed in three minutes by 0.06 g. stovaine. Ten minutes after the injection the woman was in bad condition. Pulse small and slow. Breathing slow and superficial. Cyanosed. The anæsthesia reached to the neck. Fifty minutes after the birth, sensation had returned to the navel, and the lips were red. The left leg could not be moved by the patient for seven hours and the right leg until several hours later. On the following day the patient could not properly lift the right leg. Sudden severe headache on the night of the fourth day with general pains over the body. The right leg was as though asleep. Ninth day right leg seemed to the patient icy cold, as though dead. No temperature difference between the right and left legs. Not until five weeks after the puncture did the patient first leave her bed, in which she had remained on account of pains in the back and lameness in the right leg. She could walk only with trouble. The temperature had been normal.

2. König: *Bleibende Rückenmarkslähmung nach Lumbalanæs., Münch. med. Wochenschrift, No. 23, 1906, liii, 1112.*

Needle introduced between the third and fourth lumbar vertebræ, whereupon the patient experienced pain. As soon as the liquor, which was colored light red, came from the needle in drops, stovaine-Riedel (0.06 stovaine) was injected. Anæsthesia of lower abdomen. "The lost function about from the navel downward, including bladder, rectum, and extremities did not return." On the fifteenth day a lumbar puncture was made, drawing a light red sterile fluid containing isolated red cells and mononuclear leucocytes. Patient died after three months with cystitis, etc. Autopsy: The spinal cord from about the level of the ninth vertebra downward was adherent to the dura. In the lumbar portion a space remained in which there was found no abnormal fluid. In the lower dorsal and in the lumbar regions the cord on section presented the picture of softening.

3. Bosse (Hildebrandt): *Berl. klin. Wochenschrift, 1906, xliii, 369. Disk. zu Lazarus.*

Age 59. Examination of prostate. Stovaine. At the conclusion of lumbar anæsthesia, without other toxic sequels, the paraplegia continued. The paralysis on one side lasted until the fourth day, while the paralysis on the other side remained until death, four weeks later, of an ascending nephropyelitis.

4. Goldschwend: *Ueber 1000 Lumbalanæs. mit Tropakokain Wiener kl. Wochenschrift, 1907, xx, 1098.*

"In high grade disquieting were the rare cases of long lasting paraplegia (3 in 1000). In the most severe case it lasted eight days, after which the motility gradually returned. . . . The paraplegia affected only the lower extremities and not the bladder."

II. Whole Lower Extremity Paralyses Following a Complete Recovery of Function After Spinal Anæsthesia.

Walther: *Bull. et Mem. de la Soc. de Chir. de Paris, 1905, xxxi, p. 214. Meningo-myelite consec. a la rachicocainisat.*

Male, age 20. Case admitted to hospital with the following history: February 25, 1903, subarachnoid injection of cocaine. No sequels. May 27, 1903, subarachnoid injection of cocaine without loss of sensibility. Nothing abnormal until third day, when motion and sensation of the lower extremities began to fail and progressed until at the end of ten days they had entirely disappeared. Third week incontinence of urine and fæces. After four or five months control of anus and bladder had returned to normal. After eight months the movements of the lower extremities began to return a little. After 21 months he still could not walk. Lower extremities showed some contracture, increased tendon reflexes, and spasticity. Sensation to heat, touch, and pain was present. The case was diagnosed as one of meningomyelitis.

Dandois: *Journ. de chir. et Annal de la Soc. Belge de Chir., 1901–4, p. 282.*

External urethrotomy. Age 57. 0.02 cocaine. On eighth day pains in pelvis and lower extremity. Ninth day complete paraplegia. Sensation preserved. Delirium. No fever. Twenty-fifth day slight movements in lower extremities, followed by complete recovery.

III. Localized Paralyses of the Lower Half of the Body.

Henking: *Munch. med. Wochenschrift, 1906, p. 2428. Erfahrungen über Lumbalanæsthesia mit novocaine.*

Age 28. Hernia. Novocaine. Perfect anæsthesia. After 12 hours patient became restless. Incontinence of fæces and urine lasting 60 hours.

Borszeky: *Beitrage z. kl. Chir., lviii, 1908, 651.*

Borszeky refers to a case of bladder paralysis following spinal anæsthesia reported by Wiener, of a "35-year-old perfectly sound man who suffered a total incontinence. The condition of the patient improved after sixteen months only in so far that he could hold his urine two to three hours by day, but not at night. Furthermore erection was incomplete and libido was entirely absent."

Strauss: *Deutsche Zeitschrift f. Chir., lxxxix, 1907, 275.*

Strauss reports that after performing lumbar anæsthesia with stovaine on about 300 cases without serious accident, there occurred on the same day two cases of paralysis of both bladder and rectum following lumbar anæsthesia with stovaine. The paralyses of the sphincter ani lasted 10 days. The bladder paralysis lasted in one case 1½ months, and in the other after 3 months a slight paresis still existed.

Michelsson: *Arch. f. kl. Chir., xcii, 1910, 657.*

In 400 cases of lumbar anæsthesia there followed disturbances of motion in four cases. Two had paresis of the extremities. Another had a paralyzed sphincter for four days following operation, and the other for six days following operation could not empty his bladder.

Bondy: *Gyn. Rundschau, iv, 1910, p. 99.*

Of peripheral paralyses occurring in 1000 cases of lumbar anæsthesia, there were nine of the peroneal nerve, and trophoneurotic disturbance 10 times.

Sellheim: *Medizinische Klinik, 1910, vi, p. 5.*

In 1000 operations under spinal anæsthesia, there were nine cases of peroneal nerve paralysis, all of which disappeared completely.

König: *Hohmeier u. König. Sammelforschung über die Lumbalanæsthesie im Jahre 1909. Verhandl. d. Deutsche Ges. f. Chir., xxxix, 1910, p. 481.*

König collected from the *Centralblatt für Chirurgie* in the years 1908–09, eight reported cases of paralysis of the leg following lumbar anæsthesia, usually limited to the peroneal nerve region, some of which were permanent.

IV. Unclassified Cases.

Bainbridge: *Analgesia in children by spinal injection, with a report of a new method of sterilization, etc. Medical Record, 1900, lviii, p. 937.*

Age 7. Slight lumbar kyphosis. Puncture to right of median line between twelfth dorsal and first lumbar vertebræ. Cocaine 9 mms. of a 1 per cent. solution. In nine minutes analgesia up to lower jaw. On third day, patient seemed stupid and did not move right arm and hand, and the legs were drawn up. Eighth day the legs could be extended and patient moved the right arm. Thirtieth day, " he is in excellent condition, better than before operation."

Füster: *Bruns Beiträge z. kl. Chir., 46, p. 1. Erfahrungen über spinal analgesie.*

Age 34. Appendicitis. Injection between second and third lumbar vertebræ. No anæsthesia and ethyl chloride given. Symptoms of spinal meningitis developed with opisthotonus. Eighth day lumbar puncture drew few drops of sanguinolent fluid which was sterile. Tenth day sudden improvement. Eighteenth day cured.

Allen: *Spinal anæsthesia. Boston Med. and Surg. Journ., clxiii, 1910, p. 715–718.*

Age 55. Double inguinal hernia. 1.5 c.c. stovaine Billon injected through second lumbar interspace. Rather marked Trendelenburg position for three minutes then laid flat. Soon after the beginning of the operation the patient lost consciousness and the respirations became Cheyne-Stokes in character. Had complete left hemiplegia which cleared up in less than twenty-four hours, excepting a slight paralysis of the left wrist which persisted two days longer. During the next twenty-four hours there developed a complete paralysis of right leg. This persisted for two weeks. It then gradually cleared up, and in two months was entirely well.

Note.—The writer wishes to acknowledge his appreciation of the courtesies shown to him by Dr. H. D. Senior, the Professor of Anatomy at the New York University and Bellevue Hospital Medical College, during his conduction of this work in Dr. Senior's department.

REFERENCES.

[1] Key and Retzius: Studien in der Anatomie des Nervensystems und des Bindegewebes, 1828.

[2] Propping: Die Mechanik des Liquor Cerebrospinalis und ihre Anwendung auf die Lumbalanæsthesie, Mitteil a. d. Grenzgeb. d. Med. u. Chir., xix, 1908–9, 441.

[3] Quincke: Die Technik der Lumbalpunction, Urban und Schwartzenberg, Berlin u. Wien, 1902.
Über Lumbalpunction, Deutsche Klinik, vi^{2}, 1906, p. 351.

[4] Gerstenberg and Hein: Anatomische Beitrage zur Ruckenmarks-anæsthesia, Zeitsch. f. Geburtsh. u. Gyn., lxi, 1907–08, p. 524.

[5] Magendie: Recherches physiologiques et cliniques sur le liquide céphalo-rachidien ou cérébro-spinal, Paris,. 1842.

[6] Rehn: Archiv. f. kl. Chir., xc, 1909, p. 329.

[7] Quincke: Ibid.

[8] Donitz: Technik Wirkung, und Specielle Indicationen der Rückenmarks-anæsthesia, Verhandl. d. deutsch. Gesell. f. Chir., xxxiv, 1905, Th. 2, 527.

[9] Quincke: Die diagnostische und therapeutische Bedeutung der Lumbal-punction, Deut. med. Wchsft., 1905, xxxi, 1825, 1869.

[10] Hosemann: Verhandl. d. deut. Gesell. f. Chir., 1909, p. 17.

[11] Müller: Discuss. Hohmeier u. König., Verhandl. d. deut. Ges. f. Chir., 1910, p. 481.

[12] Quincke: Deut. med. Wochenschrift, 1905, p. 1829.

[13] Gray: Internat. Clinics, iv, 1910, p. 71.

[14] Sellheim: Über Geschichte, Anatomie, und Technik der Rückenmarks-anæsthesie, Medizinische Klinik, 1910, vi, p. 5.

[15] Bier: Das zurzeit an der Berliner chir. Universitatsklinik übliche Verfahren der Rückenmarksanæsthesia, Deut. Zeit. f. Chir., xcv, 1908, p. 373.

[16] Colombani: Über 1100 Falle Lumbalanalgesie, Weiner kl. Wochenschrift, xxii, 1909, p. 1336.

[17] Strauss: Die gegenwartige Stand des Spinalanalgesie, Deutsche Zeit. f. Chir., lxxxix, 1907, 275.

[18] Sellheim: Ibid.

[19] Slamjer: Über die Rückenmarksanæsthesie mit tropacocain, Beitrage zur kl. Chir., lxvii, 1910, p. 1.

[20] Barker: British Medical Journal, 1907, i, p. 665; and *Ibid*, 1908, i, p. 244.

[21] Borschardt: Discuss. sp. anæsthesia, Verhandl. d. Deut. Ges. f. Chir., xxxviii, 1909, p. 25.

[22] Bolton: The Principles of the Treatment of Injuries of the Spinal Cord, ANNALS OF SURGERY, Philadelphia, xxx, 1899, p. 171.

[23] Gray: A Study of Spinal Anæsthesia in Children and Infants, Lancet, clxxvii, 1909, p. 913.

[24] Slamjer: Ibid.

[25] Dönitz: Ibid.

[26] Trautenroth: Ein fall von Schwerer Stovainvergiftung nach Lumbal-anæsthesia nebst Bemerkerungen über Halbseitige Anæsthesien., Deut. med. Wochenschrift, 1906, p. 7.

[27] Oelsner and Kroner: Deut. Zeitsch. f. Chir., xcv, 1908, p. 386.

THE TECHNIC OF END-TO-END ARTERIAL ANASTOMOSIS.*

WITH REPORT OF A CASE.

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VASCULAR anastomosis has developed chiefly within our own day. Its history begins, however, with the first arterial suture on June 15, 1759, when Hallowell, at the suggestion of Lambert, closed a wound of the brachial artery by passing a small steel pin, rather more than a quarter of an inch in length, through the two lips of the wound and then twisting a thread around it, as in the hare-lip operation. The closure was successful, and the pulse remained thereafter nearly as strong as in the other wrist. Asman, after fourteen years (1773), on the basis of four unsuccessful experiments on dogs, concluded that a vessel could not be sutured by this method with preservation of its lumen. Wattmann seventy years later (1843), reported that he had performed lateral ligation of a vein with success by holding up the edges of the wound with forceps and surrounding it with a ligature. Nicaise in 1872 maintained that lateral suture was practicable, and stated that Ollier and Gensoul had both performed it. Hirsch (1881) and Braun (1882) did important work on lateral suture, while Gluck (1882) devised a small ivory clamp for closing arterial wounds. Jassinowsky, in 1889, reviewed the general literature of the subject of lateral suture, published an extensive series of personal experiments, and established the procedure on a sound basis.

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* The experimental work upon which this paper is based was performed in the Laboratory of Comparative Physiology at the Harvard Medical School, through the kindness of Dr. W. T. Porter.

Eck, investigating the physiology of the liver, performed in 1877 successful lateral anastomoses between the vena cava and the portal vein of dogs. His technic resembled that of lateral intestinal anastomosis, except that the anastomotic openings were not made until all the stitches had been placed. He used for this purpose a pair of fine scissors, to each tip of which was soldered a length of silver wire terminating in a curved needle. After the posterior line of sutures had been made, these needles were passed through the vessels (one the vena cava and the other the portal vein) at points determining the length of the incision. The anterior line of sutures was then placed, the scissor-blades were pulled into the vessels by means of the wires, and the veins cut between the two lines of sutures. This technic was improved by Stolnikow (1882), Hahn, Massen, Nenchi, and Pawlow (1893), and others, and the subject of Eck fistula forms an important chapter in blood-vessel surgery.

Von Horoch in 1888 tried to sew together the ends of an artery which had been cut across; he was unable to accomplish this without interfering with its patency. Robert Abbe, 1894, of New York, was the first to successfully perform end-to-end anastomosis; he divided the abdominal aorta of a cat and "tied each end over a glass bobbin by a fine silk thread, and tied the ends together." Queirolo and Masini, working on the Eck fistula, introduced in 1895 an appliance consisting of a tube of glass through which one cut end of the artery was threaded and cuffed back and then invaginated into the other end and held in place by a ligature. Nitze in 1897, demonstrated a similar anastomotic aid made of ivory, and Von Karltrew working also on the Eck fistula, improved the technic of its use in 1899. Payr in 1900, apparently without knowledge of the above methods, described in detail two appliances made of an absorbable material (magnesium); for a short time Payr's protheses were quite popular, and from one form, similar to that of Queirolo, the Crile cannula has developed.

While these men were perfecting anastomotic aids Murphy, of Chicago, was attempting to develop a technic of suture without aids, and in 1897 he described a successful method of anastomosis by invagination. When dealing with moderately sized vessels, this method proved to be superior to that of Payr. Several men made attempts to improve the technic, especially Bouglé in 1901. Coincidently with Murphy, Jaboulay and Briau developed a method of end-to-end anastomosis by means of interrupted mattress sutures with evagination of the intima, and in 1898 they presented a specimen to the Medical Society of Lyons, in which there was a perfect union of the endothelium without any thrombus formation. Salomoni in 1900 independently devised a technic similar to that of Jaboulay and Briau. The method of Jaboulay and Briau was improved by the former's pupil, Carrel, into the method which is now generally used.

It was in 1902 that Carrel first described his now famous method of circular suture, converting the circumference of the vessel into a triangle by means of three stay sutures; he also pointed out the necessity of the use of the finest needles and silk and the maintenance of absolute asepsis. Carrel's method has become the method of choice wherever permanent union is desired and has been extensively used by both experimenters and clinicians; among others, Hubbard, Jensen, Floresco, Watts, Stich, Makkas, Dowman and Lund have used it and reported excellent results.

About two years ago we undertook to perform the operation on the abdominal aorta of cats, with the purpose of acquiring facility in the technic. Of our first series of fifteen animals no statistics were kept. Ether was administered with a cone, and the mortality from ether and from bronchopneumonia following operation was high; thrombosis was frequent.

On the basis of this preliminary experience, we perfected the technic of operation after the manner in which we shall describe it, and as we have used it since. We then undertook a second series of thirty cats, which we operated upon between the dates of January 23, and July 20, 1910. The animals were anæsthetized by the intratracheal insufflation method. The mortality statistics are as follows:

2 died of thrombosis within 24 hours.
1 died of secondary hemorrhage on 5th day.
1 died of complete rupture on 8th day.
1 died of false aneurism on 33d day.
—
5 operative deaths.

1 died of general peritonitis on 6th day.
1 died of general peritonitis on 8th day.
1 died of general peritonitis on 23d day.
1 died of gastro-intestinal on 28th day.
1 died of gastro-intestinal on 31st day.
—
5 deaths from infection and intercurrent disease.

The segments of sutured aorta were saved in the five cases that died of intercurrent disease, preserved in alcohol, and photographed (see Fig. 1). It is worthy of note that in this series there were no ether deaths and no cases of postoperative bronchopneumonia.[1]

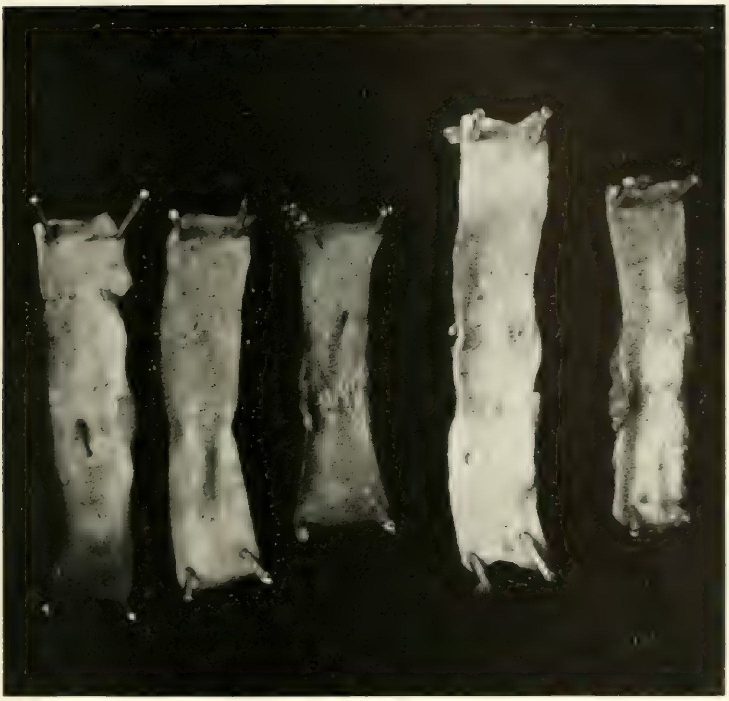
The deaths from infection and intercurrent disease were the result of the operating conditions and the housing of the cats.

Of the other twenty animals, twelve were killed August 15, 1910, at the request of Prof. E. H. Nichols of the Department of Surgical Pathology, to supply material for the demonstration of the healing of arteries. Four of the remain-

---

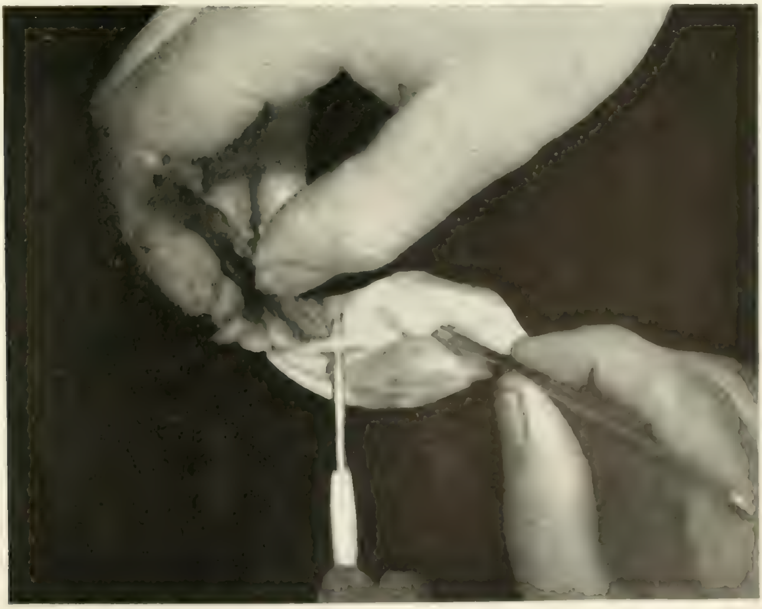
[1] The apparatus which we used consists of a Wolffe bottle half full of ether; through one stopper passes a glass tube which dips below the surface of the ether and is connected by rubber tubing with the air-pressure tap of the laboratory, and the other connects with a straight metal intratracheal tube. Another piece of tubing is connected with the tubing to and from the bottle so as to pass the air current around it, without taking up any ether vapor. This is long enough to lie in a loop upon the floor. When ether is required, from time to time, the assistant presses upon this loop for a second or two with his foot, forcing the air to bubble through the ether. A mercury bottle is connected on to serve as a safety valve, as described by Ehrenfried: Intrathoracic Insufflation Anæsthesia, Apparatus and Cases, Boston Medical and Surgical Journal, 1911, clxiv, p. 532.

FIG. 1.



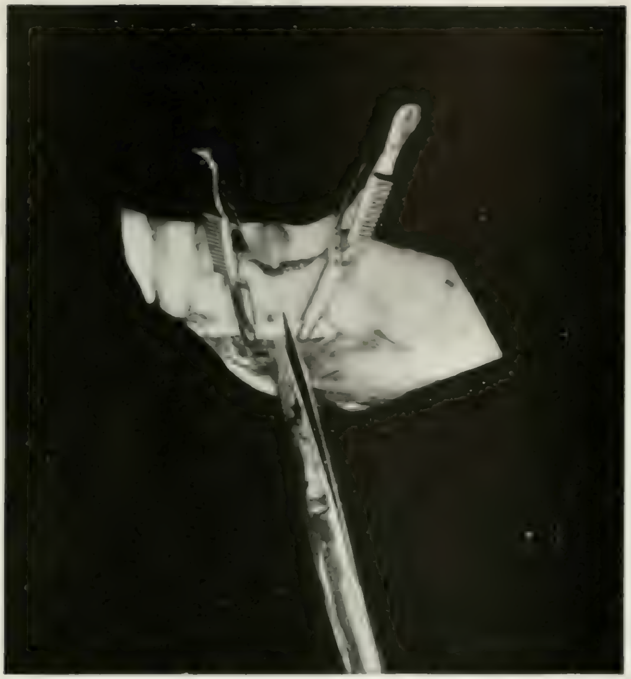
Sections of healed aortæ taken from cats which died of intercurrent disease (considerably enlarged).

FIG. 2.



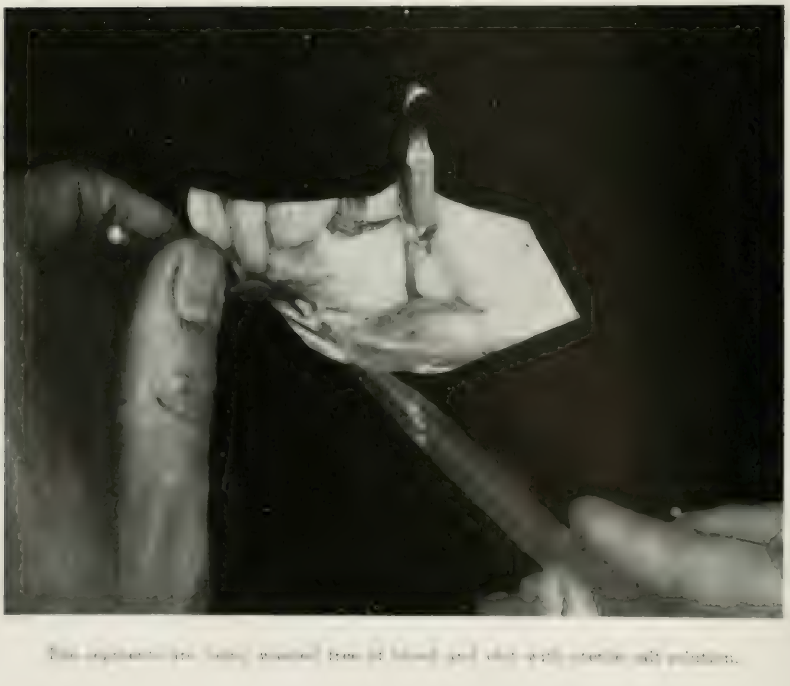
End-to-end anastomosis of divided intestinal [illegible] [illegible]. The [illegible] has been [illegible] [illegible] [illegible] and fixed [illegible] the [illegible] [illegible].

FIG. 3.



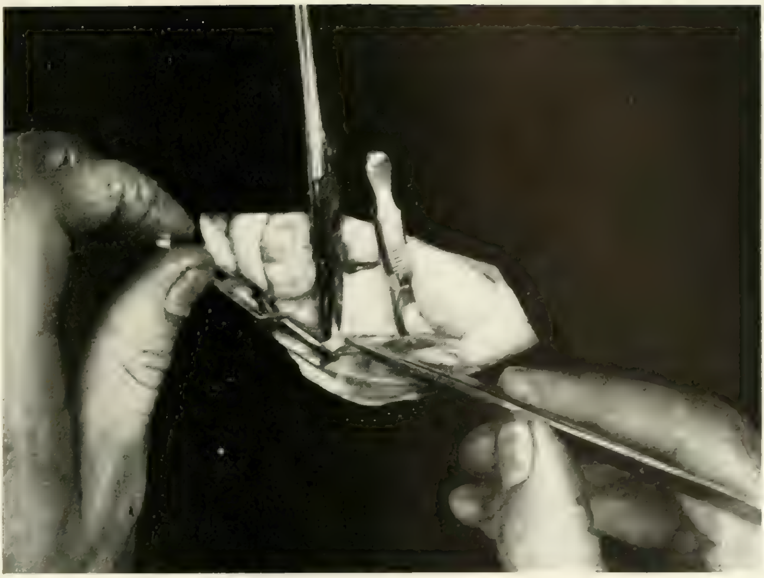
The clamps have been adjusted and the artery is being divided.

FIG. 4.



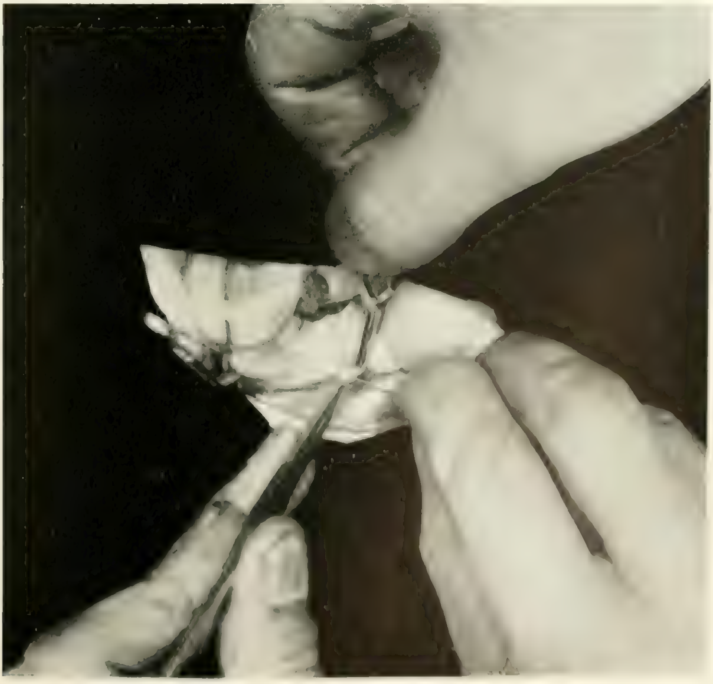
[illegible] being cleaned free of blood and clot with [illegible] and pipettes.

Fig. 5.



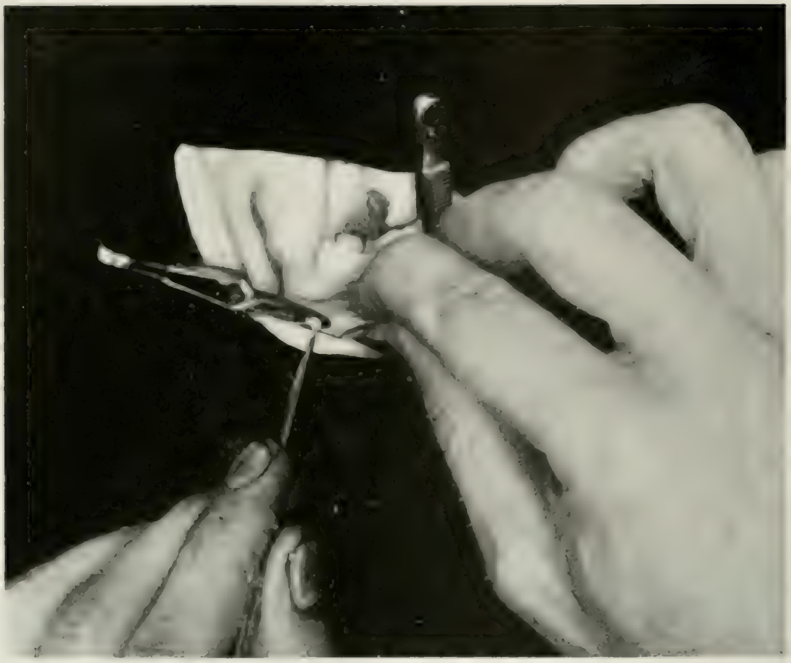
Trimming off the adventitia.

Fig. 6.



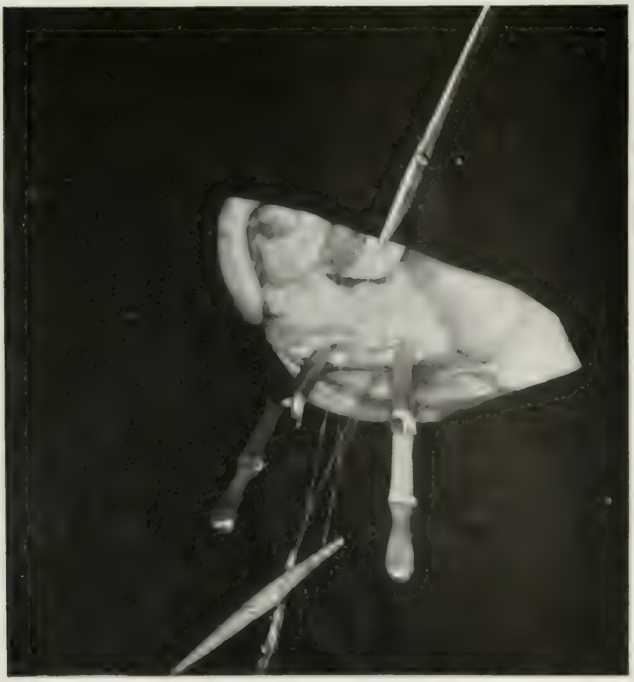
Starting the first stay suture.

Fig. 7.



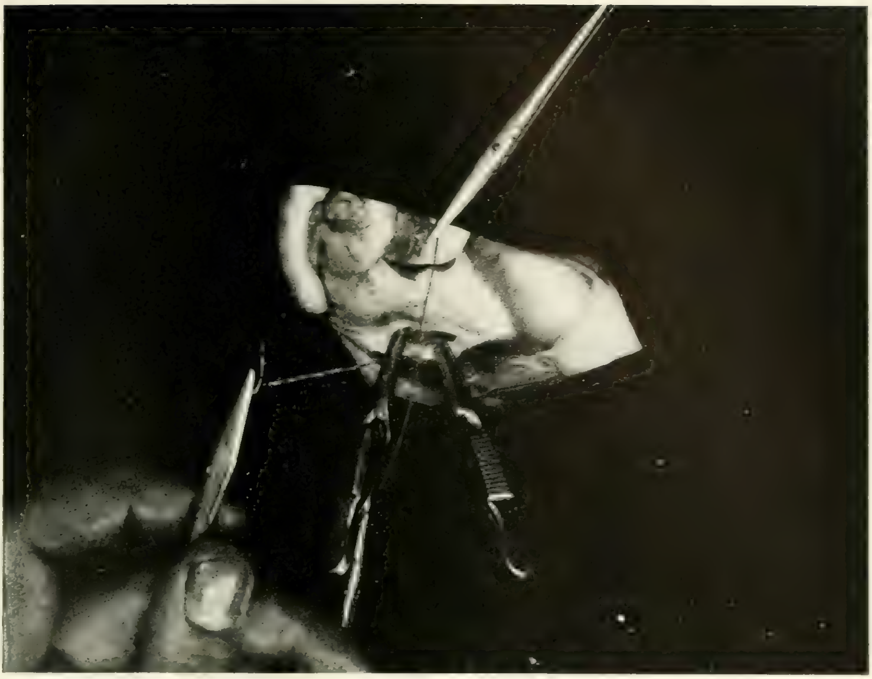
Completing the first stay suture.

Fig. 8.



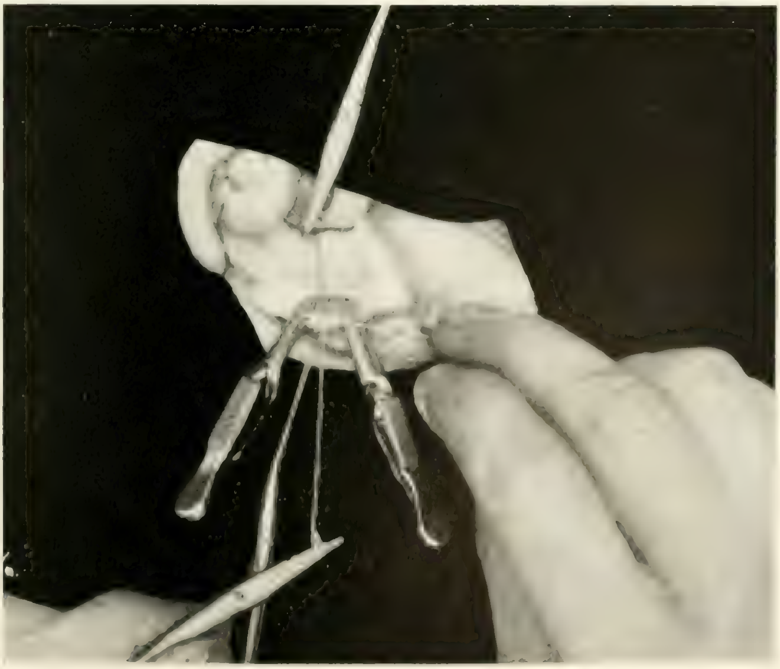
All the stay sutures in place.

Fig. 9.



The stay sutures have been drawn up and tied.

Fig. 10.



Starting the continuous circular stitch. (The needle and suture used for this animal photograph are coarser than those regularly employed.)

ing cats have died since that date, two have been used for other purposes, and two are now living (Aug. 1, 1911).

The kit which we use in operating contains the following instruments:

Six light mosquito hæmostats for use in tying off collaterals, to snap on the ends of the three stay sutures, and on the end of the running suture after it is tied, in starting. Heavy snaps will tear the vessel wall by their weight.

Two vessel clamps. At Carrel's suggestion we use the small old-fashioned "serrefine," with the blades filed smooth, and the tension of the springs weakened until the blades come together flat with the least possible pressure. On large vessels in the human, Crile clamps may become necessary, but the serrefine is preferable because it is lighter and more easily handled. It is a wise precaution in human surgery to apply a Crile clamp some distance proximal to the cut, to provide against the possibility of slipping of the serrefine.

One blunt dissector, to assist in freeing up a sufficient length of vessel for operative purposes. We make use of a straight blunt aneurism needle.

One fine blunt scissors, curved on the side, to trim off adventitia.

Two pair of smooth jeweler's forceps (Boley, MM, filed blunt). These we have found to be the best adapted of any forceps for handling the fine needle.

One medicine dropper and sterile saline solution, for flushing out the segments of artery before sewing.

One bottle of vaseline, in which to sterilize the silk sutures.

Fine Pagenstecher, for tying off small branches cut in freeing the artery. Catgut swells up and interferes with the operation.

Needles, No. 6 Kirby sharps.

Suture material, No. 0000 Chinese silk, untwisted into the three strands of which it is composed. About 18 inches is threaded on the needle, the needle is stuck through a square of card, and the silk is wound about this. Two such cards are enough for an operation; one length will make the three stay sutures, and another will suffice for the continuous suture. On account of the difficulty of threading, it is wise to economize in the suture material. If the needles are allowed to remain for long in the vaseline, they are likely to become brittle.

The ability to perform end-to-end arterial anastomosis comes only as the result of practice, gained upon the living animal. The best subject of experimentation is the cat; it is inexpensive and not hard to care for. The abdominal aorta is easy to get at; it is approximately the size that would be met with in human surgery, slightly larger than the brachial and slightly smaller than the femoral artery. If the artery thromboses, or if the lumen is sewed up (the commonest mishaps in the beginner), the cat dies.

The animal selected is given no food the night before. For operation it is strapped upon the board, etherized, and the hair clipped from its belly which is washed with soap and water and rinsed with alcohol. Operative asepsis in all its details is essential; gloves, however, are not worn. The operator stands upon the cat's right. An incision is made from one inch below the ensiform to one inch above pubes. A snap is applied to peritoneum and fascia on either side and thrown back. The intestines are taken out and wrapped in a hot towel on the cat's left. (A black silk laparotomy sheet, with one side long for covering the intestines, is a distinct advantage; against it the needle and silk can be readily seen.) The laparotomy sheet is pinned to the edges of the wound by Bachaus towel clamps to prevent exposure of the skin, and to avoid getting hairs into the operative field.

The retroperitoneal space is opened up by blunt dissection, and the aorta is freed for a distance of about three-quarters of an inch between the superior and inferior mesenteric arteries. Occasionally one or two posterior-lateral branches will have to be tied off; double snap with mosquitoes and tie short with very fine Pagenstecher or silk. Tie off as few branches as possible, because the ties get in the way, and because if the branches which supply the cord are cut the cat dies within twenty-four hours with paralysis of the hind legs. Lift up the vessel on the blunt dissector, apply the clamps, perpendicularly, about one-half inch apart, and cut between. Gently wash out the segments of vessel with salt solution in the medicine dropper, and then apply a little warm vaseline to the cut edges with the blunt dissector. Trim off any redundant adventitia or any connective tissue that might get in the way when suturing.

The three stay sutures are now placed at points equidistant about the circumference of the artery, one stitch being exactly posterior, corresponding to the tips of the clamps. The needle is passed directly through the vessel wall of the proximal segment, including the intima, and is passed back (from within outward) through the distal segment at the corresponding point. If there is any difficulty, the vessel wall may be grasped by the forceps, which have been dipped in vaseline. The stay is not tied, but its ends are left long, and grasped by a mosquito snap. When the last one has been placed, they are all gently drawn up so as to approximate the cut edges of the artery. While the assistant holds two taut, the operator ties the third, snugly, using a surgeon's knot to prevent slipping. The other two are tied in turn; the tied ends of all are left long and snapped with mosquitoes. The ends of the posterior stay should come out on the cat's left.

Everything is now ready for the application of the continuous suture. The clamp handles are directed to the operator, and the first stitch is applied just anterior to the posterior stay suture. A tie is made to start from; its end is left long, and is snapped by the mosquito on the posterior stay. The operator holds the stay suture toward which he is sewing in his left hand, while his assistant holds the stay from which he is sewing, applying enough pull so as to keep the section which is being sewed on the stretch. The third stay, which lies beneath, is slackened up and relieved of the weight of its snap, otherwise the under wall of the artery might be pulled up against the anterior, and the two sewn together. The assistant pulls up with his right hand the slack of the running suture, after each stitch is passed, so as to evert the edges and bring intima to intima. (If the operator prefers to sew away from, rather than toward himself, he ties the posterior stay so that the ends come out on his side, and starts the running suture just anterior to it. In this case the assistant, with his right hand across the table, will hold the two stays, and the surgeon will pull up his own slack.) About six stitches usually suffice for each of the three sections.

The first section being completed, the assistant takes the stay which the operator was holding, the operator picks up the next one, the handles of the clamps are directed to the side of the assistant, so as to expose the next section, and the suture is continued. When this section is completed, the operator cuts close the stay which the assistant is holding, which is no longer needed. The assistant then passes the long end and the posterior stay, which are snapped together, under the artery. The clamp handles are directed back to the side of the assistant, so as to bring the third section into view. The suture is continued, the operator taking the stay which was passed under, and the assistant the other. This section being completed, the ends of the running suture are tied to each other and cut. The stays are cut and the clamps removed, the distal one first.

There is practically always leakage of blood in some amount, usually through the stay holes, which have been stretched by the pull upon the stay sutures. If the anastomosis is otherwise competent, this ooze will stop in a half minute, some loose gauze being applied over the site of operation. If more than gentle pressure is applied on the gauze, a thrombus is apt to form within the artery. Where there is no leakage, there is probably thrombosis, and the pulsation of the vessel will have disappeared below the anastomosis. In this case the thrombus may sometimes be broken up and sent along by massaging and "milking" the artery. If the artery "spurts" through one hole, where a stitch has cut through, for instance, the clamps may be reapplied and the hole sewed over, with some show of success. In case there is more than one tear, the anastomosis had better be cut out and performed over again.

The intestines are replaced, and the peritoneum and fascia of the abdominal wall are sewed up together with a running buttonhole stitch of Pagenstecher, and the skin likewise. No dressing is applied. The entire operation should take thirty-five minutes or less; the clamps should not be on longer than fifteen minutes.

The advantage of being prepared to apply this technic to human traumatic surgery is suggested by the following case, which we report through the courtesy of Dr. L. R. G. Crandon, Assistant Visiting Surgeon, Boston City Hospital, who invited one of us to assist him in the treatment thereof.[2]

T. G., Syrian, was brought to the Relief Station of the Boston City Hospital at 4.30 P.M., April 23, 1911, by a police ambulance, with the story that he had been stabbed in the left groin. He was conscious, restless and pale, pulse 80, of small volume and low tension.

Just below Poupart's ligament on the left was a narrow, somewhat pouting, clean-cut slit in the skin about three-quarters inch long, running nearly transversely. There was considerable blood on the thigh and the clothes covering the thigh. About the wound was some swelling. No pulsation in the femoral artery or its branches below this point was made out.

The thigh was cleaned and shaved. On the passing of a director into the wound, to ascertain where to introduce a wick, active arterial hemorrhage ensued. The wound was packed, and a sterile dressing was applied with pressure. Heaters and blankets were ordered, and salt solution administered by rectum.

Patient was cold, restless, and weak for two or three hours, but then became more quiet, stronger, and warmer. There was no return of pulsation in the branches of the femoral artery. Operation was advised and accepted.

Operation, Drs. Crandon and Ehrenfried: Under ether an incision was made above and parallel to Poupart's ligament. The external iliac artery was found and a Crile clamp applied. An incision five inches long was made over and parallel to the femoral artery, the region of the punctured wound was laid open, and the dissection carried down to the femoral artery. This was found completely severed, though the ends were held together beneath by some strands of uncut adventitia. The surrounding tissues were infiltrated with blood-clot. The vein and nerve were intact.

Crile clamps were applied to the artery, the adventitia trimmed away, and the ends sewed together by the technic just described. The clamps were taken off, and then the clamp on the iliac artery was removed. There was some oozing of blood from the anastomosis, which ceased in two minutes under light pressure. Pulsation was readily felt beyond the suture.

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[2] We are indebted to Dr. Paul Thorndike, Surgeon-in-Chief, Boston City Hospital, for permission to publish the following record.

The abdominal wound was sewed up in layers, the thigh wound by mass sutures. Sterile dressing was applied. Stimulation, heaters and blankets.

The recovery was rapid and uneventful, despite the weakness of the patient from loss of blood. When seen the next day the left foot was warm, and on the day following pulsation of the dorsalis pedis could be readily made out, and heaters and blankets were discontinued. The temperature and pulse were normal on the fourth day, and remained so. On May 3 the stitches were removed, and on May 7 the patient went home, well except for a small granulating area at the site of the original wound.

We have applied this technic also in one case of transfusion, but without satisfaction. We consider the ordinary methods of transfusion, of which that of Elsberg is undoubtedly the best, more rapid and certain. The chief difficulties to suture in transfusion are the inequality in size of the vessels, their difference in texture, and the possibilities of tension under which the operation is performed. There is no question, however, but that the Carrel method of end-to-end anastomosis has already made for itself an important place in operative surgery.

REFERENCES.

(To the more important articles only.)

Lambert: Account of a New Method of Treating Aneurism, Med. Observations and Inquiries, London, ii, 362, 1764.

Asman: Die Aneurysmata, Groningue, Dissert, 1773. Lauth's "Scriptorum Latinorum de Aneurysmatibus Collectio, etc.," 1785.

Wattmann: Sicheres Heilverfahren bei dem schnell gefährlichen Lufteintritt in die Venen, Wien, Braumüller, 1843.

Nicaise: Des plaies et de la ligature des veines, Paris, Asselin, p. 92, 1872.

Eck: Zur Lehre von der Ligature der Pfortader, Militär Medicinisches J., cxxxi, 1877 (see Stolnikow, 1882).

Hirsch: Suture of Veins and Arteries, 1881, quoted by Clermont, 1901.

Gluck: Naht der Blutgefässe, Arch. f. klin. Chir., xxviii, 547–555, 1882.

Braun: Ueber die seitlichen Verschluss von Venenwunden, Arch. f. klin Chir., xxviii, 654–672, 1882.

Stolnikow: Die Stellung v. Hepaticarum im Leber u. im Gesamtem Kreislaufe, Pflüger's Arch., xxviii, 255–286, 1882.

V. Horoch: Die Gefässnaht, Allgem. Wiener med. Zeit., xxxiii, 263–264; 279–280, 1888.

Jassinowsky: Die Arteriennaht, Dorpat, Dissert, 1889.

Hahn, Massen, Nenki, u. Pawlow: Die Eck'schen Fistel., Arch. f. exp. Path. u. Pharm., xxxii, 161–211, 1893.

Abbe: The Surgery of the Hand, N. Y. Med. Jour., lix, 33–40, 1894.

Queirolo u. Masini: Ueber die Function des Leber, etc., Moleschott: Untersuchungen zur Naturlehre des Mensch., xv., 225, 1895.

Jaboulay et Briau: Recherches Exp. sur la suture et la greffe arterielles. Lyon Medical, lxxxi, 97–99, 1896; Lyon Medical, lxxxvii, 305, 1898.

Nitze: Gefassnaht, Ctlbltt. f. Chir., xxiv, 1042, 1897.

Murphy: Resection of Arteries and Veins in Continuity; End-to-end Anastomosis, Med. Record, li, 73–88, 1897; Int. med. Kong. (Moskau), v. 359–381, 1897.

V. Karltrew: Eck'sche Fistel, Wien. klin. Woch., xii, 205–206, 1899; Arch. f. exp. Path., xlv, 56–65, 1900.

Payr: Beitrage zur Technik der Blutegefässnaht, Arch. f. klin. Chir., lxii, 67–93, 1900; Langenbeck's Arch., lxiv, 726–740, 1901.

Bouglé: Sutures arterielles, Arch. de méd. exp. et d'anat. path., xiii, 205-224, 1901.

Salomoni: Sutura circulare delle arterie con l'affrontamenta del endothelia, Clinica Chir., No. 4, 1900; Ctrlblat f. Chir., xxviii, 464, 1901.

Clermont: Suture latérale et circulaire des veines, La presse Médicale, ix, 229–233, 1901.

Carrel et Morel: La technique operatoire des anastomoses vasculaires et la transplantation des viscères, Lyon Médical, xcviii, 859–864, 1902; Lyon Medical, xcix, 114–116; 152–153, 1902.

Carrel and Guthrie: Uniterminal and Biterminal Venous Transplantation, Surg. Gyn. and Obst., ii, 266–286, 1906.

Carrel and Guthrie: A New Method of Vascular Anastomosis, XV Congrès Internat. de Méd., Lisbonne, ix, 238–249, 1906.

Carrel: Surgery of the Blood-vessels, Bull. Johns Hopkins Hosp., xviii, 18–28, 1907.

Watts: The Suture of Blood-vessels, Johns Hopkins Hosp. Bull., xviii, 153–179, 1907.

Stich, Makkas, and Dowman: Gefasschirurgie, Beit. z. klin. Chir., liii, 113–160, 1907.

LATERAL VASCULAR ANASTOMOSIS.

AN IMPROVED METHOD.

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AND

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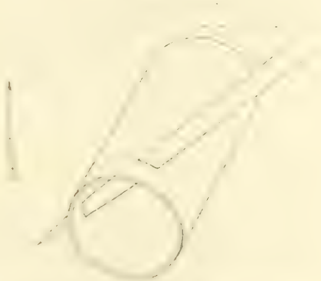
IN the course of an experimental study of arteriovenous aneurisms, concerning certain physiological and surgical problems presented by these lesions, the method herein to be described was developed for making lateral anastomoses between blood-vessels. It is published because it seems superior to previous procedures, either for experimental or clinical purposes. A brief description is all that is necessary to supplement the illustrations.

The artery and vein between which the communication is to be established are carefully dissected out, and bull-dog or Crile clamps, rubber-shod, are applied to each vessel at corresponding points. The incision in the artery is made first. A sharp cataract knife, held transverse to the long axis of the vessel, is plunged through the artery in a direction oblique to the horizontal plane in which the vessel lies, so as to form a sector of the lumen with its arc equal to about one-third of the circumference. The knife is thrust in with its cutting edge upward and toward the adjacent vein. The overlying one-third of the artery wall is then divided (Fig. 1). At once the retraction of the longitudinal muscle and elastic fibres causes this transverse incision to gape and become an open ovoid (Fig. 2). Owing to the fact that the knife was entered obliquely and not perpendicularly, this ovoid looks toward the vein and also somewhat upward. The posterior edge of the opening is thus easily accessible for suturing. As soon as the artery is opened all blood is washed out with salt solution, the adventitia stripped off carefully, and the lumen and other surfaces freely bathed with liquid vaseline. These are precautions common to all vascular surgery—thanks to Carrel—but demand restatement because of their importance. The artery is then protected with vaseline-soaked gauze, and a similar incision, corresponding in size and position, is made in the vein so that it looks toward the artery and upward.

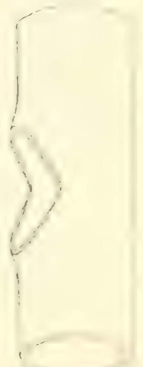
The suture[1] is started by passing the needle through the wall of the artery from without inward, then crossing to the vein and passing here from within outward (Fig. 3). When this suture is tied the knot lies outside the vascular lumen (Fig. 4). From this starting point a simple continuous suture is carried around the openings in the two vessels (Figs. 5 and 6), care being taken to avoid purse-stringing. The operation is completed by tying the last suture to the remaining long end of the first tie. No difficulty is experienced in approximating the edges of the incisions, and there is no more tension on the thread than in an end-to-end anastomosis. After completion of the suture, the clamps are removed first from the vein, as in all vascular

FIG. 1.



Introduction of knife and direction of incision.

FIG. 2.



Gaping of transverse incision.

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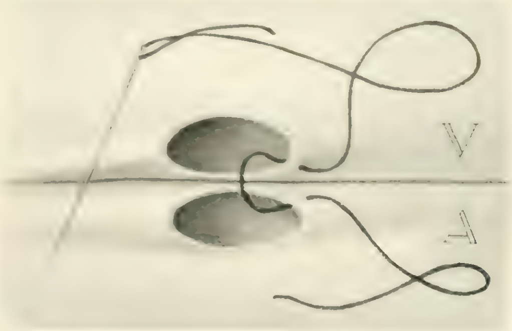
[1] The suture material consists of a straight needle, size 16, ground down, and silk, size 0000, which has been sterilized in vaseline.

surgery. If any marked leakage occurs, the weak spots are reinforced by one or two extra sutures. Then the arterial flow is gradually allowed to go over. During the suturing, intima is not always approximated to intima, but with the establishment of the arterial stream through the anastomosis, the "pull" in opposite directions between the two vessels helps to bring about an accurate approximation.

This method has been employed with great satisfaction a considerable number of times in animals, and was equally simple in execution in the one clinical case in which we have so far had the opportunity to try it. After an interval now of three months, this patient's anastomosis is working splendidly. It is intended to report this case in detail later, with several other clinical cases in which other methods of arteriovenous anastomosis have been used. The rationale of this method has been deduced from a consideration of the cases of arteriovenous aneurism met with in the clinic. Previous laboratory anastomoses have been performed by making longitudinal incisions in the vessels rather than transverse. In the clinical cases following trauma there seems little doubt that the wounds are transverse. A bullet, knife-blade, or other object wounds the adjacent surfaces of artery and vein at the same level. The vessels are held closely together by their investing sheaths, the transverse incisions gape, as illustrated in these sketches, and the gaping lips soon adhere. The method described in this paper is practically a copy of this accidental anastomosis occurring in nature.

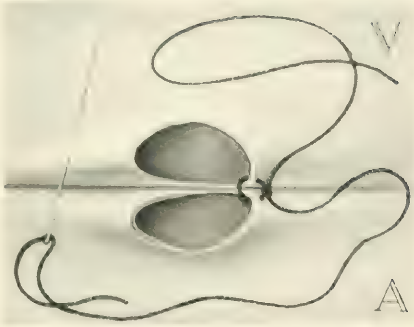
We think that this anastomosis, with a ligation of the vein on the cardiac side of the point of union, offers a much easier and safer method for reversal of the circulation than the present procedure of end-to-end anastomosis of artery and vein, with ligation of the proximal stump of the vein and the distal stump of the artery. When the latter method is used a failure of the anastomosis imperils the knee or elbow, owing to the complete division of the arterial trunk; and as a rule the disease process which leads one to do an

FIG. 3



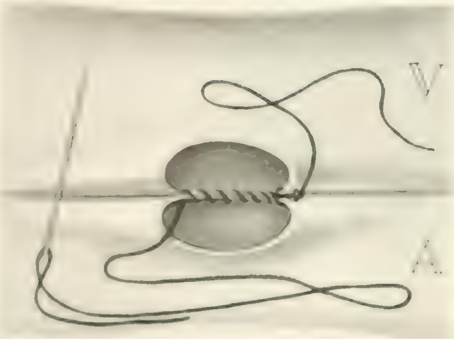
Initial suture placed.

FIG. 4



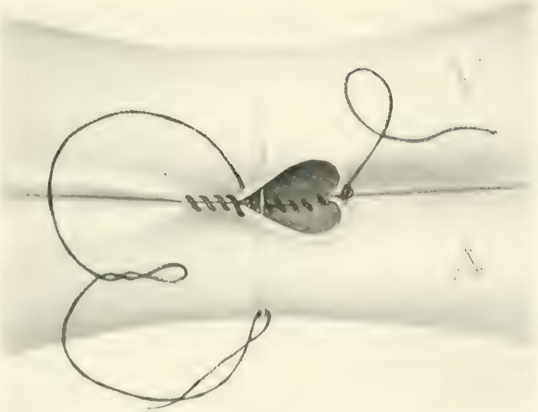
Initial suture tied.

FIG. 5.



[illegible]

FIG. 6



Posterior part of suture completed and about half of anterior part placed.

arteriovenous anastomosis is not in itself so advanced as to threaten the larger joints. In the few experiments with the new method in which thrombi developed, they never obliterated the arterial lumen, but were entirely lateral. Moreover, by this procedure, the inflow of blood into a threatened extremity still has whatever arterial channels remain patent, and the venous trunk in addition may be utilized to carry some of the needed excess. It is important to ligate the vein above the anastomosis, to protect the heart from a direct back flow of blood under arterial pressure into its right chamber.

In brief conclusion, this method is presented because of its easy execution, making it superior to the longitudinal incision for experimental work, and because of its safety, making it better than the end-to-end for reversals of the circulation and other clinical conditions.

SOME RECENT MECHANICAL AIDS TO HOLLOW VISCERAL ANASTOMOSIS.

BY C. E. TENNANT, M.D.,

OF DENVER, COLO.

SUTURE methods in hollow visceral anastomosis have, in recent years, become so universal that they may practically be considered the method of choice. This is especially true with the through-and-through suture known as the Connell.

I have found it of advantage in lateral anastomosis to adopt Willard Bartlett's method of using two needles in the one catgut suture, placing the first stitch in the middle of the two approximating edges and approaching both angles early in the operation.

To successfully perform anastomosis with this method, holding clamps are necessary to fix the parts in close apposition during the operation. When two or more clamps are used for this purpose, it requires all the assistant's attention to keep the parts to be approximated in close apposition. More assistants in the field of operation brings added interference, and also increased danger of infection.

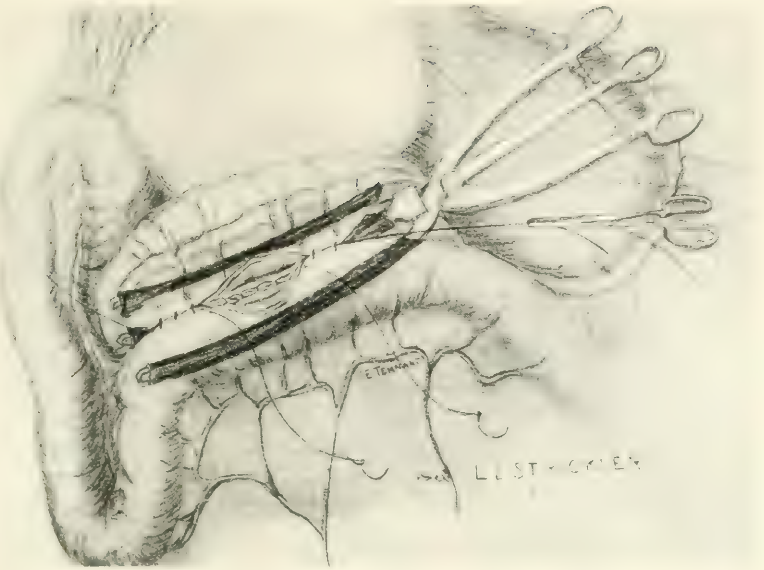
To obviate these objections we have, within the past few years, devised two instruments which we believe materially simplify the technic of visceral anastomosis.

One of these is the three-pronged compound clamp known as the "Roosevelt clamp," which was devised by my assistant, the late Dr. G. F. Roosevelt, and myself some six years ago. This clamp was designed solely for gastro-enterostomies, and with its several modifications is now quite generally in use and accomplishes several purposes.

First: It holds the parts to be anastomosed absolutely fixed in the position in which they have been placed, and no amount of manipulation can disarrange them.

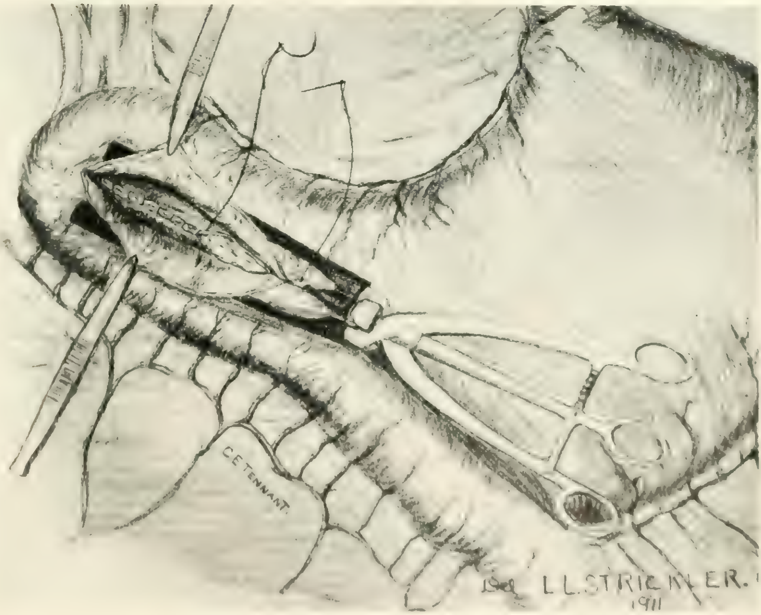
Second: There is no need of the instrument being held.

Fig. 1.



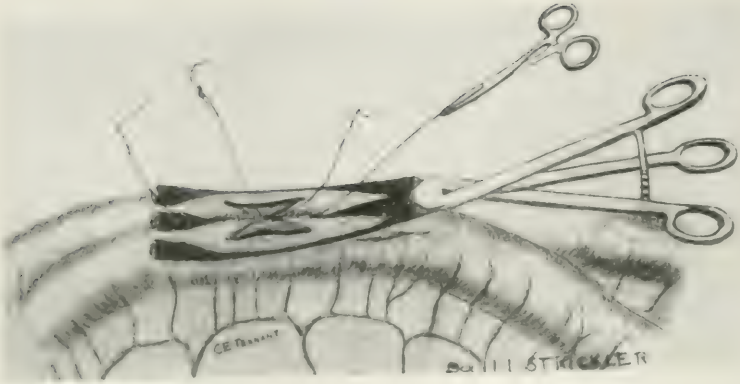
Posterior gastro-enterostomy with the Roosevelt clamp.

Fig. 2.



Finney's pyloroplasty with the Roosevelt clamp.

FIG. 3.



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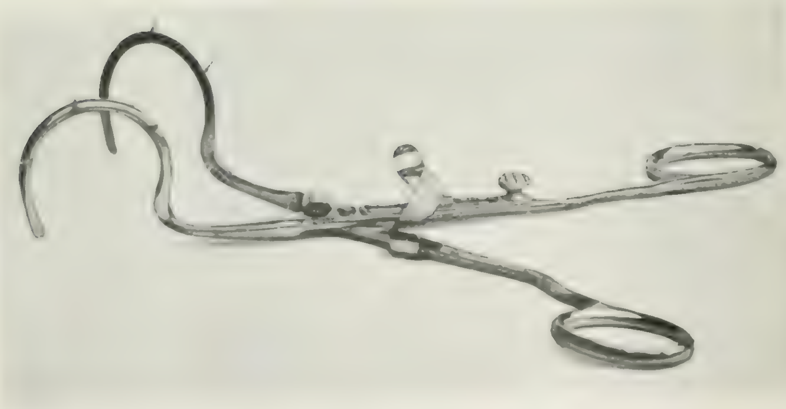
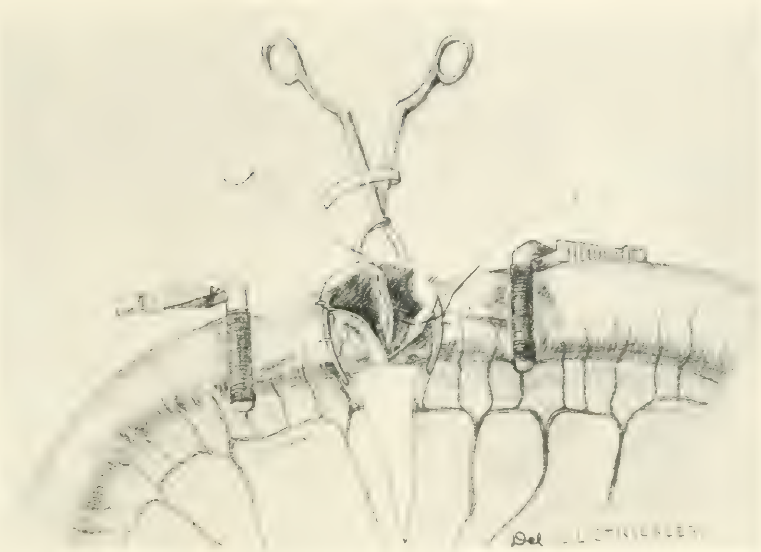


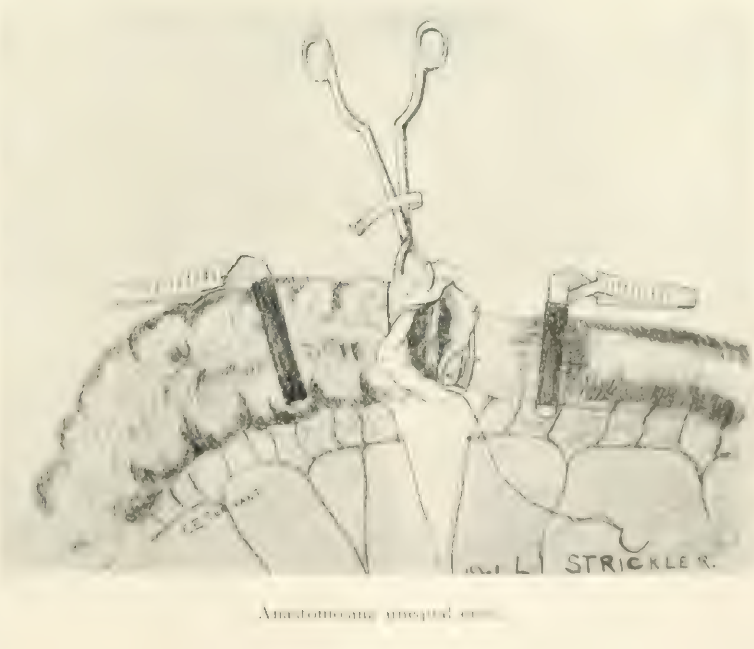
[illegible] intestinal [illegible]

Fig. 5.



End-to-end suture anastomosis with help of clamp.

Fig. 6.



Anastomosis, unequal ends.

since it is heavy enough to lie on the patient's abdomen with the parts fixed in position, while the one assistant has both hands free to aid the operator (Fig. 1).

This clamp is, of course, adapted to either posterior or anterior operations. The same clamp with the straight prong is also extremely practical in the pyloroplasty of Finney (Fig. 2), and in gastric anastomosis after partial gastrectomy.

An imitation of this three-pronged clamp, called the "Lennartz clamp," followed about six months after the Roosevelt. It is a much lighter and smaller instrument, and I have found it especially practical for pyloroplasty and lateral intestinal anastomosis (Fig. 3). It, too, leaves the hands of the assistant free to aid the operator.

The second instrument is that of an end-to-end anastomosis clamp. While the use of end-to-end anastomosis is not practicable in every case, still my experience has been that where this form of anastomosis is made in the ileum and colon with suitable instruments, it can be accomplished in one-half the time consumed by a lateral anastomosis, and if the modern theories of Lane and others regarding the kinks, flexures, and stagnation are tenable, then the end-to-end anastomosis is far more consistent to employ than the lateral. These reasons alone, I believe, are sufficient to justify the more frequent employment of the end-to-end anastomosis when it can safely be accomplished.

The instrument to which I refer, and which I recently devised for this purpose, automatically holds the ends of the severed gut in an open and fixed position while suturing, and it also leaves the assistant's hands free for other work. The instrument is simple in construction and manipulation (Fig. 4).

The method, briefly described, is to pass the two ends of the intestines under the loops of the instrument, the handles of which point away from the operator. The intestine is then impaled on the three pins in their respective loops. When the loops are separated the dangerous mesenteric border is brought well up to the surface, where a curved needle with a long suture (preferably chromicized) is passed through both ends of the bowel on the opposite side from the operator, and midway between the dome and the mesenteric border (Fig. 5). The suture is continued on around through the mesenteric border and up on the side nearest the operator until the dome is reached. The needle is then transferred to the loose end left for this purpose, where the suture was first commenced, and enters the peritoneal surface including all coats of the bowel.

The intestine is now released from the pins and the suture continued on over the dome, keeping well outside of the three perforations made by the instrument. The two approximated ends of the suture are then tied from the outside. It is surprisingly simple to anastomose the ends of unequal bowel with this instrument (Fig. 6), and the resulting infolding of the smaller gut into the larger is very much similar to the recent Gibson peritoneal invagination method.

The advantages of using this instrument are: (1) the safety of the complete circular suture; (2) the definite care of the dangerous mesenteric zone, and (3) the economy of bowel, since by this method it need be no more than an approximation.

LIGATION OF THE FIRST PORTION OF THE LEFT SUBCLAVIAN ARTERY.

WITH REPORT OF A RECENT SUCCESSFUL CASE.

BY JAMES M. NEFF, M.D.,
OF SPOKANE, WASH.

RECOVERY so rarely follows ligation of the first portion of the left subclavian artery, especially in the presence of severe infection, that I think the following case worthy of record.

CASE REPORT.—Mr. H. W., age twenty-three years, single. In December, 1909, patient first noticed an enlargement of the glands in the left side of the neck.

Patient entered the Deaconess Hospital, Spokane, on February 11, 1910. In left side of neck there was a chain of enlarged lymphatic glands extending from the mastoid process to the clavicle. The centre of the mass was more prominent, tender to pressure, and presented deep fluctuation. There was considerable periadenitis, the glands being adherent to each other and quite immovable. Examination of heart, lungs, and abdomen negative.

Operation, February 12, 1910: An incision was made, extending from the mastoid process downward along the anterior border of the sternomastoid muscle to the middle of the neck, then backward, severing the muscle, and continuing down to the clavicle along its posterior border. The chain of enlarged glands was reached through this incision, and their removal begun from below by clearing the space between the internal jugular vein and the clavicle. The glands and infiltrated gland bearing tissue in this situation was dissected free with some difficulty, but without apparent injury to any of the important structures in the neighborhood. The lower angle of the wound was then tamponed to produce distention of the internal jugular vein, and the dissection of the glands was continued in an upward direction. This was accomplished with a good deal of difficulty, owing to the extensive periadenitis and suppuration in the centre of the mass. It was finally completed, however, and we were about ready to close the wound, when there was a sudden gush of blood from the lower part of the wound behind the clavicle. The hemorrhage was very profuse and came on without the slightest warning, as we had been working in the upper part of the neck and had not touched the lower portion since the beginning of the operation. The flow of blood was stopped by pressure with the fingers behind the clavicle, and the field cleared by sponging. An examination was then made and it was found that the hemorrhage had come from the subclavian artery just internal to the scalenus anticus muscle. By cautiously moving the fingers inward, the outer border of the small opening in the artery was revealed. A hæmostat was then placed on the vessel in this situation and two more to the inner side of the first, thus closing the opening. The wound in the neck was now closed in the usual manner, after uniting the cut ends of the sternomastoid muscle with catgut sutures. A drainage tube was placed in the upper part of the wound on account of the secondary infection, and the hæmostats were allowed to protrude through the lower angle of the incision.

Patient was returned to bed in fair condition, with pulse 110 and temperature 100.8° F.

On February 14, 48 hours after operation, the hæmostats were carefully removed and two moderately firm gauze packings were inserted, one upon the other behind the clavicle and down to the artery. No bleeding occurred immediately after the removal of the forceps, but three hours later the patient had a very severe hemorrhage which stopped spontaneously. The outer packing was then removed and replaced by a firmer one, which was held in position by a tight adhesive plaster drawn across the wound and over the shoulder. After the hemorrhage the patient was anæmic and pulse went up to 118. On February 18, four days later, there having been no hemorrhage in the interval, the outer packing was removed, but the one next to the artery left undisturbed. The wound looked well, though there was slight purulent discharge from the upper part through the drainage tube. Pulse 112, temperature 101.6° F. Early the next morning, 11 hours after the last dressing, patient had another very severe hemorrhage. On the 19th he became delirious and on the 20th had two more hemorrhages. From this date until the 25th, there were no hemorrhages, his pulse went down to 98, temperature nearly to normal, and we were greatly encouraged about his condition. On February 25 another severe hemorrhage occurred, and between this date and March 4, a period of seven days, he had fourteen hemorrhages of greater or less severity. During this time the temperature ranged from 99.6° to 101° F. On February 27 cultures were taken by Dr. Frank Hinman from the pus in the drainage tube for the purpose of making autogenous vaccines. On this date, slight œdema of the arm and weakening of the radial pulse were noted, the result of long-continued pressure on the subclavian artery. On March 3 Dr. Hinman injected 150,000,000 bacteria in right arm. On March 4, condition of patient became so grave that we decided that his only hope lay in the ligation of the first division of the subclavian. This procedure had been considered several times before, but as we had been unable to find in the literature the report of a single successful case of ligation of the first portion in the presence of sepsis, we had looked upon the operation as a last resort. At the time we decided to ligate the artery our patient had a temperature of 103.6° F., pulse 160, and he was delirious from anæmia and sepsis. For five hours before the operation we kept up continuous digital compression of the artery, as the hemorrhage would recur whenever the pressure was released.

Operation, March 4, 1910, 7.30 P.M.

Before beginning the operation an intravenous saline transfusion was given in the median basilic vein of the right arm.

An incision was made along the upper border of the clavicle, from the outer third to the sternoclavicular articulation and then upward for 2½ inches through the old incision along the posterior border of the sternomastoid. An abscess cavity containing several drachms of foul-smelling pus was found beneath the latter muscle. The clavicle was divided with bone-cutting forceps 1¼ inches from the sternum, and the ends retracted in a downward direction, thus giving good access to the subclavian space. Up to this time pressure on the subclavian had been maintained, but when all was in readiness the pressure was released and the packing removed. A gush of blood immediately followed but was at once controlled by direct pressure with the fingers, followed by the application of hæmostats to the opening in the artery. The scalenus anticus was next divided, the thyroid axis and vertebral artery recognized, and the subclavian dissected free in a downward direction from the surrounding structures. The dissection was particularly difficult because of the previous operation and the infection of the field, which had caused a matting together of all the tissues. By careful work, however, the subclavian and innominate veins were isolated and drawn forward and the thoracic duct recognized and separated from the artery. After the vessel was completely isolated, two attempts were made to ligate it in the upper portion of the first division, but both ligatures cut through the outer coats and had to be removed. Finally three-quarters of an inch above the aorta the wall was strong enough to tolerate a ligature, and a double strand of medium sized silk on an aneurism needle was passed from below upward, behind, and around the vessel. This double ligature was tied in a simple square knot (not the Ballance and Edmunds stay knot) just tight enough to occlude the artery and stop pulsation. A hæmostat was then clamped on the vessel about one-quarter inch distal to the ligature. Another double silk ligature was tied around the artery distal to the opening in its wall and a second hæmostat applied proximal to it. The thyroid axis, vertebral, and internal mammary arteries were then ligated with silk and the forceps removed from the wound in the subclavian. A loose packing of iodoform gauze was placed in the deep cavity behind the clavicle, the ends of the clavicle united with aluminum bronze wire, and the external wound closed with interrupted silkworm gut sutures.

When patient was returned from the operating room, his pulse was 140 and temperature 103° F. For ten days after operation the blood-pressure was kept below 112 mm. of mercury by diminishing the amount of ingested liquids and giving spirits of nitroglycerin whenever it reached that point.

Restlessness was controlled by hypodermics of morphine. Five days after operation the autogenous vaccines were again given and repeated every three or four days thereafter. The temperature ranged from 100.2° F. to 104.2° F. and pulse 120 to 150, until March 19, fifteen days from time of operation, after which both gradually went down to normal. Patient continued delirious at intervals until March 15. The hæmostats were removed from the ligated vessels on March 13, nine days after operation. On March 13, he developed a right-sided pleurisy and cough, with yellowish expectoration. His temperature was 103° F. to 104° F. and pulse 130 to 140 for a few days, but the trouble entirely subsided within a week. On March 19 the ends of the clavicle, which had become separated, were reunited. He was allowed out of bed for the first time on March 20, sixteen days after operation. The wound, which was infected at the time of operation, continued to suppurate until the patient left the hospital on April 2, although it filled rapidly with granulations and was about flush with the clavicle at the time of his discharge.

The radial pulse disappeared when the artery was ligated and has not returned to date, sixteen months after operation.

The peripheral circulation remained good after the ligation and the hand and arm were warm at all times.

Marked atrophy of the arm, forearm, and hand took place during the two or three months following operation, and there was great weakness of all the muscles of the left upper extremity from shoulder to fingers.

Tactile and pain sense were abolished over the lower third of the forearm, hand, wrist, and fingers for four months, and muscular sense in the hand was greatly impaired for the same time.

As a result of almost constant exercise, frequent massage, and faradic electricity to the weakened and atrophied muscles, the muscular power is now about normal and the muscles have regained their normal volume and tone. There still remains, however, slight impairment of tactile sense in the tips of the fingers. The general health of the patient at the present time is perfect, weight up to normal, and he is able to attend to his regular business affairs.

This case presents a number of interesting features. First: The manner in which the artery was injured. We had finished our dissection in the subclavian space, apparently without injury to any important structure, and in fact had completed the entire operation when the hemorrhage suddenly occurred without apparent cause. The only possible explanation was a weakening of the vessel wall produced during the separation of the adherent glands and infiltrated gland-bearing tissue.

Second: The youthfulness of the patient. This was undoubtedly an important factor in the successful outcome of the case, as statistics show that the large percentage of recoveries after ligations of the great vessels occur in young individuals, due probably to the greater elasticity of the vessels. It is well known that healthy elastic vessels tolerate ligation better and are less likely to cut through than diseased ones. Collateral circulation is also more readily developed in them, as they offer less resistance and distend more easily.

Third: The favorable influence of the autogenous vaccines. So far as can be learned from a study of the literature this is the first successful case of ligation of the first surgical division of the left subclavian artery, where the operation was performed in an infected field and the wound continued to suppurate afterward. In view of this fact we are inclined to attribute to the use of the vaccines a part, at least, of the credit for the recovery of the patient. The culture from the pus taken by Dr. Hinman on February 27 showed the *Staphlylococcus aureus* and *albus* and the *Streptococcus*. A vaccine was made from each of these organisms after the method of Wright, mixed and counted. From March 3 to April 5 injections of the vaccines, ranging in amount from 150,000,000 to 550,000,000 bacteria, were given every two or three days.

Fourth: The application of hæmostats distal to the proximal ligatures and proximal to the distal ligatures, and the retention of them in place for nine days after the operation. Just how much this had to do with the favorable result we are not prepared to say, as we are unable to find in the literature any record of a case similarly treated. The flexible bladed forceps were placed close to the ligatures and probably took some of the strain from the ligated portion, as the silk was tied just firm enough to obliterate pulsation and not sufficiently tight to injure the intima.

Fifth: The influence of long-continued pressure on the artery before operation upon the development of efficient collateral circulation. This was probably another important factor in bringing about a successful result. It will be noticed in the record that from the time we removed the hæmostats, two days after the first operation, until the date of the ligation, a period of eighteen days, there was practically continuous pressure on the vessel. This pressure was exerted through the gauze packing most of the time and was sufficient to cause œdema of the arm on February 27, and weakening of the radial pulse on February 28. This continuous pressure undoubtedly had much to do with the development of the collateral circulation prior to the ligation of the artery. The only evidence of severe disturbance of nutrition in the extremity after the ligation was a very small painless perforating ulcer in the tip of the middle finger. This came on about three weeks after operation, perforated to the bone, and then promptly healed.

A few words here in regard to the surgical anatomy[1] of the subclavian artery may not be out of place. The relations of the second and third portions are the same on both sides, while those of the first division differ on the right and left. This is due to the fact that the right subclavian is given off from the innominate and the left arises direct from the aorta. The right vessel is three inches long, and arises just behind the right sternoclavicular joint. The first portion, internal to the inner border of the scalenus anticus, has in front of it the right vagus nerve, the cardiac branches of the vagus and sympathetic, and the internal jugular and vertebral veins. Behind it are the recurrent laryngeal nerve and the apex of the right pleura. The left subclavian artery is four inches long, and arises from the aorta behind the lower part of the manubrium sterni. The first portion, internal to the scalenus anticus, is in relation anteriorly with the following structures: The left vagus nerve, the left superior cardiac branch of the sympathetic, the left inferior cardiac branch of the vagus, the left phrenic, and the left common carotid artery. It is crossed obliquely by the left innominate vein above and is overlapped on the left side by the left lung and pleura. Posteriorly it is in relation on the inner side with the left margin of the œsophagus and the thoracic duct and on the outer side with the pleura. Internally it is in relation from below upward with the trachea, the left recurrent laryngeal nerve, the œsophagus, and thoracic duct. Externally it is closely invested by the left pleura.

Collateral Circulation.—When the artery is ligated in its first portion distal to the origins of the vertebral, thyroid axis, and internal mammary arteries, the collateral circulation takes place through the following anastomoses:

1. Branches of the suprascapular (from thyroid axis) with the superior thoracic (from first part of axillary).
2. Between the internal mammary and the superior thoracic.
3. Between the suprascapular and the acromiothoracic (from second part of axillary).
4. Between the internal mammary and the acromiothoracic.
5. Between the posterior scapular branch of the transverse cervical (from the thyroid axis) and the subscapular (from third part of axillary).
6. Between the suprascapular and subscapular.
7. Between the acromial branches of the suprascapular and the posterior circumflex (from third part of axillary).
8. Between the intercostals and the pectoral branch of the acromiothoracic.
9. Between the intercostals and the long thoracic (from second part of axillary).

If the ligature be applied to the subclavian proximal to the origins of the vertebral, thyroid axis, and internal mammary arteries, the collateral circulation will develop as follows:

1. Between the intercostals and the pectoral branch of the acromiothoracic.
2. Between the intercostals and the long thoracic.
3. Between the lateral branches of the intercostals and the subscapular.
4. Between the aortic intercostals and the anterior intercostal branches of the internal mammary.

5. Between the inferior phrenic (from the aorta) and the musculophrenic branch of the internal mammary.

6. Between the deep epigastric (from the external iliac) and the superior epigastric (from the internal mammary).

7. Between the deep branch of the princeps cervicis (from the occipital artery) and the superior intercostal (from first portion of subclavian on left side and the second portion on the right side).

8. Between the occipital (from the external carotid) and the ascending cervical branch of the inferior thyroid (from thyroid axis).

9. Between the ascending pharyngeal (from the external carotid) and the ascending cervical branch of the inferior thyroid.

10. Between the œsophageal branches of the thoracic aorta and the œsophageal branches of the inferior thyroid.

11. Between the superior thyroid (from the external carotid) and ascending terminal branches of the inferior thyroid.

12. Between the inferior thyroid of the opposite side and the inferior thyroid of the same side.

13. Between the arteria princeps cervicis (from the occipital) and the superficial cervical artery (from the transverse cervical).

14. Between the dorsal branches of the intercostals and the posterior scapular branch of the transverse cervical.

15. Between the occipital artery (from the external carotid) and the muscular branches of the second part of the vertebral.

16. Between the princeps cervicis and the anastomotic branches of the third part of the vertebral.

17. Between the right and left vertebral arteries through the circle of Willis.

It will thus be seen that the opportunities for the development of collateral circulation are numerous, whether the ligature is applied proximal or distal to the origin of the branches. This fact explains why gangrene so seldom follows ligation of the artery.

An important factor in the establishment of collateral circulation after ligation of the great vessels is the increased pressure in the general circulation and the lowered pressure in the segment beyond the ligature.

The time of return of the radial pulse varies greatly in different cases, depending upon the number and efficiency of the collaterals. In some cases, however, where the circulation continues perfect, so far as nutrition is concerned, the radial pulse never returns. In one case reported by Koch it was felt immediately after the vessel was tied, in two cases in the first twenty-four hours, and in twelve cases during the first five days. In the remainder the pulse returned later, in one after six months.

In most of the cases, the temperature of the ligated side is lower than that of the other, but in a few it has been higher.

Sir Astley Cooper attempted to tie the first portion of the left subclavian artery in 1809, but abandoned the operation, thinking that he had injured the thoracic duct. The first ligation of the vessel on record was done by Colles in 1815.[2] The patient died. Dr. J. Kearney Rogers of New York ligated the first portion on the left side in 1846.[3] His patient died of hemorrhage on the sixteenth day. Halsted, of Baltimore, in 1892[4] successfully tied the first portion on the left side for aneurism of the subclavian and axillary arteries, and in 1898 performed another successful ligation while removing a tumor from the subclavian region, Dr. John C. DaCosta ligated the vessel twice, with recovery of both patients, and Nassau, of Philadelphia, successfully ligated it in its first division for aneurism of the third portion. B. F. Curtis in 1897 and Allingham in 1899 both reported successful cases.

The mortality statistics of ligation of the subclavian vary greatly, depending upon whether the cases were tabulated before or after the aseptic era. Thus Polland's statistics show that in the pre-antiseptic era ligation of the vessel, regardless of the portion ligated, gave a mortality of 70 per cent. The best results were obtained in the third portion. The first division was ligated eleven times with eleven deaths. Since the beginning of the antiseptic era, however, the mortality has been only 22 per cent., irrespective of the portion ligated. H. Lilienthal[5] secured notes on 89 cases of ligation of the subclavian for aneurism before 1890. The mortality rate from all causes for the entire number, irrespective of the portion of artery ligated, was 52.8 per cent. He further states that the mortality of ligation of the first portion of the vessel on the right side has fallen from 75 per cent. in 1890 to 16 per cent. in 1906. He attributes this diminution in mortality to the use of the stay knot of Ballance and Edmunds.

According to Koenig, the first portion of the right subclavian has been ligated 20 times with one recovery, death being due to secondary hemorrhage in the great majority of cases. Asthurst collected 19 cases of ligation of the first portion with a mortality of 100 per cent, one patient dying on the thirty-sixth day. Sir J. C. Erickson gives a table of 14 cases operated on with 14 deaths. Deaver, in 1889, reported 16 cases with 13 deaths, and Bryant, 21 cases with 19 deaths. J. D. Bryant[6] in his "Operative Surgery" states that the subclavian artery has been ligated in its three divisions 250 times with 134 deaths. Jacobstahl[7] collected 47 cases of proximal ligations for aneurism, of which eight were of the first division. Seven of the eight cases died, five from hemorrhage, one from exhaustion, and one from rupture of the sac. Of the eighteen cases of ligation of the first portion collected by Wyeth all ended fatally. In five of these, the common carotid was also tied. Death was due in most cases to hemorrhage from the distal segment of the artery.

Causes of Death.—By far the most frequent cause of death is secondary hemorrhage, which may occur at any time from the end of the first week to the sixtieth day. If the wound continues to discharge after the operation, the patient is not out of danger until the sinus closes, no matter how long it may remain open. This is doubtless due to the fact that the sinus is kept open by the ligature material acting as a foreign body, which therefore maintains an open tract from the artery at the point of ligation to the surface of the body. Furthermore, as this sinus is always infected, we have the added danger of sepsis, with possible ulceration of the ligature into the lumen of the artery and consequent fatal hemorrhage.

Secondary hemorrhage is probably also favored by tying the ligature too tight and thus injuring the intima. Halsted thinks that if the coats of the artery were not divided but merely compressed by the ligature, and if absorbable material were used instead of silk, the mortality would be much lower. H. Gilbert Barling[8] shares this opinion with Halsted. J. A. Blake[9] also thinks that there would be little danger of late hemorrhage if the ligature did not injure the intima. A ligature tied with the ordinary knot is more likely to ulcerate through the wall at the position of the knot than one tied after the method of Ballance and Edmunds. This method consists of passing two separate strands of ligature material around the vessel, tying each in a simple knot in the same direction, and then, by using the two strands on each side as one, completing the square knot.

A diseased condition of the vessel wall is another very important cause of secondary hemorrhage, and is one of the chief factors concerned in the late bleeding that occurs after the ligation of the great vessels for aneurism. Arteriosclerosis, syphilis, and local sepsis are the principal lesions which we meet with in this connection. If, on the other hand, the walls of the artery are healthy and the vessel elastic, there is less tendency for the ligature to cut through. This is due to the fact that the local pressure is better resisted and the collateral circulation develops more rapidly than in diseased vessels.

The primary and determining cause of secondary hemorrhage, however, is the enormous intravascular pressure which is constantly pounding against the blind end of the vessel. Naturally, then, the nearer the ligature to the heart the greater the pressure and the more likely it is to cut through (Oberst).

Secondary hemorrhage may take place either from the proximal or distal end when the vessel is ligated in continuity. Oberst[10] states that it is usually the distal end which bleeds after the ligature cuts through, the central end often being thrombosed. It would seem, therefore, that the application of two separate ligatures, a short distance apart, would give greater security against this accident when the vessel is ligated in continuity.

Sepsis is another frequent cause of death, as is shown by the statistics of the pre-antiseptic era. It may prove fatal: first, by inducing a general septicæmia; second, by setting up a diffuse mediastinitis; third, by causing a septic thrombus in the ligated vessel, with septic emboli in different parts of the body; or, fourth, by favoring ulceration of the ligature into the lumen of the vessel and thus causing secondary hemorrhage. Oberst says that if sepsis is present, the patient is doomed to die and that attempts at secondary ligation in an infected field are almost always futile. Sepsis, the result of gangrene of the limb, may also figure as a cause of death.

Shock, pneumonia, pulmonary embolus, cerebral embolus, air embolism from injury of the internal jugular, subclavian, or innominate veins, and injury to the pleura and thoracic duct, have all been mentioned as causes of death after ligation of the first portion of the subclavian artery.

It is a remarkable fact that gangrene rarely follows ligation of the subclavian artery, and is accounted for by the abundant anastomoses and numerous collaterals on both sides of the ligated portion. Cases have been reported, however, where gangrene of the entire upper extremity followed the operation, and others where the fingers or portions of the hand have become necrotic. E. Wolff [11] reports from the clinic of Dr. E. Lexar 12 cases of ligation of the subclavian artery (part not specified) with two cases of gangrene. One of these was a traumatic aneurism of the subclavian and the other an aneurism of the radial artery, where the brachial was first ligated and later the subclavian.

Rotter collected seven cases of ligation of the subclavian artery, in one of which the vein was also tied. In none of these did necrosis develop. Jacobstahl quotes Poiret's statistics of surgically treated aneurisms of the innominate artery. There were 72 cases treated as follows: first, ligation of the right subclavian or axillary—five times with recovery in all cases; second, ligation of the right subclavian or axillary and right common carotid—65 times with recovery in 37. Among the 42 cases that recovered there was one of gangrene of the right arm, 2.4 per cent. The older statistics of Koch give 212 ligations of the subclavian above the clavicle, or of the innominate, with three cases of gangrene of the arm and four of necrosis of the hand or separate fingers. In 45 ligations under the clavicle there were no cases of gangrene.

According to Von Bergmann, in 90 ligations of the subclavian artery for gunshot wounds (1877) there were no cases of gangrene of the arm, and in only three was there necrosis of the fingers. In the latter cases the injury was very severe.

Five cases of ligation of the subclavian artery with five recoveries have been reported during the past five years.[5 9 12 13 14] All of these operations were done for aneurism of the right subclavian or innominate arteries, and all of the patients were over forty years of age; one was sixty-three. In one case, the circulation of the arm was poor at first, but improved soon after the operation, and in another there was slight cyanosis for a time. There was no necrosis in any of the cases. Chromic catgut was the ligature material used in three of the cases, and silk in one.

REFERENCES.

[1] Cunningham's Anatomy.
[2] Colles: Edinburgh Med. and Surg. Journal, 1815, xi, 1.
[3] Dennis's System of Surgery.
[4] Halsted: Johns Hopkins Bulletin, 1892, iii, 93.
[5] Lilienthal, H.: Journal of A. M. A., 1906, xlvi, 872.
[6] Bryant, J. D.: Operative Surgery.
[7] Jacobstahl: Deut. Zeitschr. f. Chir., 1903, lxviii.
[8] Barling, H. Gilbert: Birmingham Lancet, 1905, xi, 823.
[9] Blake, J. A.: ANNALS OF SURGERY, 1906, xliii, 919.
[10] Oberst: Beit. z. klin. Chir., 1904, xli, 466.
[11] Wolff, E.: Beitr. z. klin. Chir., 1908, lviii, 762.
[12] Da Costa, J. C.: Journal of Surgery, Gynæcology and Obstetrics, 1910, x, 620.
[13] Prince, E. M.: Alabama Med. Journal, 1908, ix, 21, 473.
[14] Pearse, H. E.: Medical Brief, St. Louis, 1908, xxxvi, 189.

FIBRO-EPITHELIAL TUMORS OF THE MAMMARY GLAND.

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THIS communication is based upon the study of 44 breast tumors which were obtained from the operating rooms and laboratories of the Massachusetts General Hospital.[1] Microscopic sections of each tumor were available for study, and the gross specimens in many cases were preserved or photographed. The clinical data were obtained from the hospital records and from personal communications from the surgeons in charge. The pathological condition was made the prime consideration in dividing and classifying the cases in different groups, but the clinical data for each group have been collected and analyzed to distinguish so far as possible the symptomatology and differential diagnosis of the different forms of tumors.

The classification of breast tumors published by Dr. J. Collins Warren[2] makes of the fibro-epithelial tumors of the mammary gland two main types, (*a*) fibrous, and (*b*) epithelial, according to the preponderance of one or the other tissue. This distinction is important from a clinical point of view on account of the greater predisposition to malignancy which is shown by tumors of the epithelial type. The tumors of the fibrous type are those in which the connective tissue preponderates over the epithelium. They are mixed tumors, like the other intrinsic tumors of the mammary gland, and contain both epithelial ducts and fibrous stroma, but because of the preponderance of the fibrous stroma and its similarity to, and probably origin from, the fibrous tissue immediately surrounding the ducts of the gland, they have been called by Dr. Warren "periductal tumors." In the Warren classification they are divided, according to the cell characteristics of this fibrous tissue, into three groups: periductal fibroma, periductal myxoma, and periductal sarcoma. It is the tumors of these three groups, together with those of the fibrocystadenoma group of the epithelial type that form the basis of this communication.

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[1] The writers would here express their thanks to Drs. C. B. Porter, J. C. Warren, H. H. A. Beach, A. T. Cabot, J. W. Elliot, M. H. Richardson, F. B. Harrington, S. J. Mixter, W. M. Conant, C. L. Scudder, J. G. Mumford, F. G. Balch, Hugh Williams, Hugh Cabot, Lincoln Davis, and Dr. A. P. Torrey for the use of their material, and to Drs. W. F. Whitney and J. Homer Wright for assistance in collection of specimens and much valuable criticism.

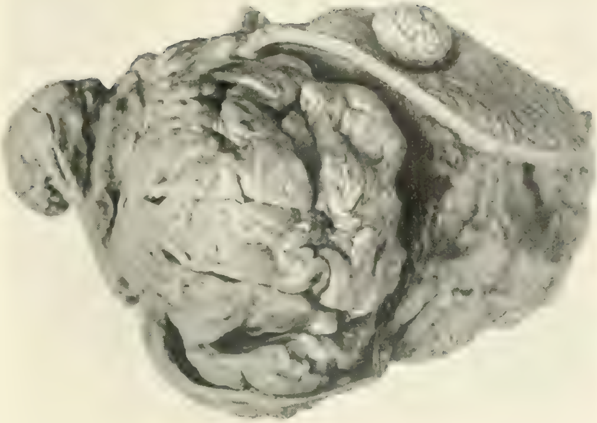
[2] J. Collins Warren: Jour. Amer. Med. Assn., July 15, 1905. *Fibro-Epithelial Tumors.*—(*a*) Fibrous type: 1, periductal fibroma; 2, periductal myxoma; 3, periductal sarcoma. (*b*) Epithelial type: 1, fibro-cystadenoma; 2, papillary cystadenoma.

PERIDUCTAL FIBROMA.

There were 27 cases which come under the classification of periductal fibroma in this series. These tumors correspond in gross and microscopic pathology and in clinical characteristics with tumors which have been reported by other writers by a variety of different names, such as "chronic mammary tumor," "cystosarcoma," "intracanalicular papillary fibroma," "fibroma," "adenofibroma," "fibro-adenoma," "intracanalicular myxoma," "adenocele," etc., a sufficient indication of the confusion which has existed in the minds of different pathologists and surgeons with regard to the assignment of these tumors to their proper category.

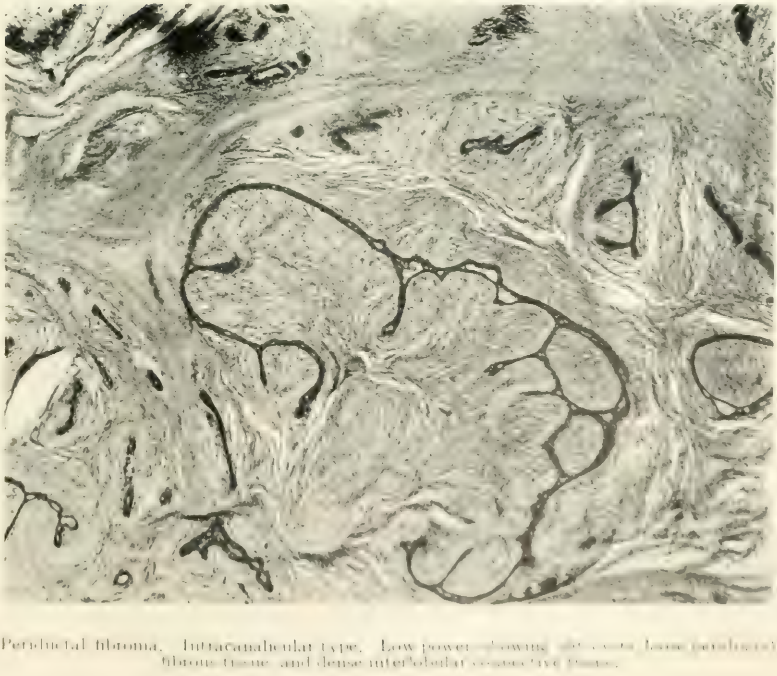
The pathological characteristics of the 27 periductal fibromata were as follows: 20 were single tumors; 7 were multiple. The size of the tumor varied in this series from that of a small marble to a mass as large as an orange. The tumors affected the right and left breasts with equal frequency, and in two

Fig. 1.



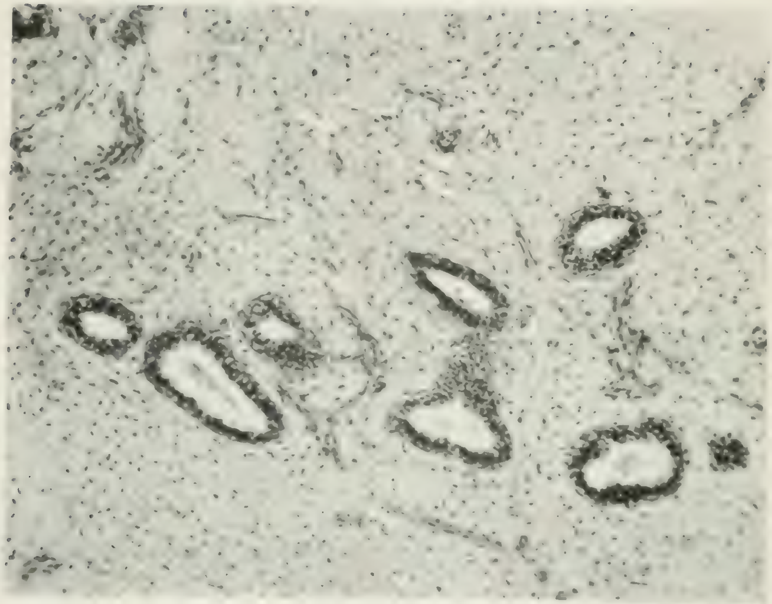
Periductal fibroma. Dissected tumor showing encapsulation and lobulation. Note small accessory nodule attached to larger tumor by slender stalk. (Warren Museum, Harvard Medical School.)

Fig. 2.



Periductal fibroma. Intracanalicular type. Low power showing the [illegible] loose periductal fibrous tissue and dense interlobular connective tissue.

[illegible]



[illegible] [illegible], high power, "normal" looking [illegible] tissue, [illegible] and ducts. [illegible] in [illegible] connective tissue due to [illegible].

cases there were tumors on both sides. Sixteen of the 27 were in the outer hemisphere against 8 in the inner hemisphere, and 13 in the upper against 8 in the lower half of the breast; 2 occupied a central position beneath the nipple and areola.

In contour the periductal fibroma is generally irregularly rounded and lobular. Small tumors by their rounded form and elastic consistency may closely resemble a cyst imbedded in the breast tissue. The consistency of the larger tumors, however, is distinctly hard and fibrous, although occasionally degenerative changes or cyst formation may produce perceptible softening of the tumor mass.

From the rest of the breast tissue the tumors of the periductal type are clearly separated by a distinct capsule. This is one of their most distinguishing characteristics. Some tumors in their earlier stages of growth possess a remarkable mobility, and can be slipped about from one place in the breast to another, by reason of the absence of infiltration in the surrounding tissues external to the capsule. Only in the rarest instances and in the case of the largest tumors, is there any indication of adherence to the skin or to the underlying structures, and then as a result of an inflammatory process such as may be produced by irritant applications or by the various forms of degeneration.

On section these tumors present an irregular surface, gray-white to pink in color, with either clefts or pearly translucent areas scattered here and there. Strands of dense connective tissue dividing the whole tumor into lobular masses are frequently observed. In many tumors an œdematous condition of the fibrous tissue, both gross and microscopic, occurs, which produces a gelatinous appearance and has led to their classification as myxomata by certain writers. The pearly translucent spots on the cut surface are the divided ducts and lobules of the tumor, and clefts and small cysts are not infrequently produced by the distortion or blocking of these ducts. In large tumors the cleft formation may be so pronounced as to give the appearance of a large cyst nearly filled with many rounded papillary outgrowths of fibrous tissue projecting from its walls (intracanalicular papillary fibroma).

On miscroscopic examination these tumors are composed of a stroma of fibrous tissue, through which pass epithelial-lined gland ducts, cysts or clefts. The fibrous tissue is itself divided into lobular masses by bands of dense connective tissue which form the framework of the whole tumor and support the blood-vessels and lymphatics. The whole mass is thus to be compared to a distorted replica of one of the racemose gland lobules of the mammary gland. The fibrous tissue which forms the bulk of the tumor is similar to that which immediately surrounds the ducts in the adolescent breast to which attention was first called by Billroth, and more recently by Warren. This tissue is delicate and rich in nuclei as compared to ordinary connective tissue and its cells have more oval and vesicular nuclei. It also appears to be more succulent, and its fibres are often separated by collections of fluid, which give it an œdematous appearance and produce marked variations in the color reaction in specimens stained with hæmatoxylin and eosin.

The epithelial elements of the tumor appear on microscopic examination as epithelial-lined ducts, or cysts, or clefts. Their number and character vary in different tumors and frequently in different portions of one tumor. They undoubtedly arise from the ducts of the mammary gland, or from the embryonic epithelial elements from which the ducts are derived, but they do not appear to be continuous with the ducts which open at the nipple. In many cases the epithelial elements are few in number, and present the appearance of gland ducts of varying size, which have been distended and distorted by the growth into and around them of the periductal fibrous tissue. This produces the slit cysts so characteristic of these tumors, which have led to their being called "intracanalicular papillary fibroma." In other instances the epithelial elements are more numerous and appear to have kept pace with the growth of the fibrous tissue, so that in place of the distorted clefts a uniform tissue is produced, consisting of many small epithelial-lined tubules separated by a stroma of periductal fibrous tissue. In some cases a grape like grouping of the smaller lobules can be recognized. In others the orderly arrangement is lost, and the lobules lie helter-skelter in the fibrous stroma. The tumors of this latter variety have usually been classified as fibro-adenoma or adenofibroma, and Rodman has recently adopted the term "pericanalicular" to describe them, as opposed to the tumors with the slit cysts or clefts which he calls "intracanalicular." It seems to us best to retain them both under one heading, because, although the two extremes of type can be clearly recognized, there are many tumors which show the characteristics of both classes, and a distinction in every case is an impossibility. It is certain, however, that the "intracanalicular" type is the more common.

The epithelial cells of these different forms of gland ducts are of much variety. In the larger clefts and ducts compressed columnar cells, similar to those lining the larger milk ducts, are usually found. In the smaller lobules, cuboidal, more clearly defined, and larger cells are present. When cysts are formed all varieties of epithelium, from flattened to cuboidal and even high columnar cells, are sometimes present. From the characteristics of the epithelium we have at times supposed that in the tumors of the "intracanalicular" type the process originated in the larger ducts, whereas in the "pericanalicular" group it was the terminal portions of the gland ducts (acini) which were concerned. This supposition, however, is quite incapable of proof. Cysts occur in tumors of both groups, but in the pure pericanalicular tumors they are rarely of large size while in the other class they may obtain considerable dimensions.

The activity of growth of the ductal epithelium in these tumors seems to be of slight extent. Occasionally a mitotic figure is observed, but the impression is given that the epithelium has merely kept pace with the changes of size and shape of its basement membranes, produced by the new growth of the periductal tissue. It is true that a certain number of tumors, which probably originate in the periductal group, do show greater epithelial activity than has been described above, but these tumors will be discussed further on, under a separate class as "fibrocystadenomata."

The clinical characteristics of the periductal fibromata are fairly well defined. They are the common tumors of the breast in young women. In a table prepared for a paper by Dr. Warren it was found that they gave 45 per cent. and 50 per cent. of the tumors in the breasts of women from 10-20 and 20-30 years of age, while in later decades the proportion diminished very rapidly. Of the 27 cases in this series the oldest was 40, the youngest 15, and the average 28.8. The majority occur in unmarried women, and the tumor is independent in its origin of the stimulus of pregnancy or lactation. They are, as a rule, of slow growth and of long duration, the average in our series of cases being 22.1 months before operation. In some cases a sudden period of rapid growth may supervene after a long time of relative quiescence. In other cases an increase in size of the tumor has been distinctly noted during the menstrual period, and this is often accompanied by an increased sensitiveness, if not by actual pain. In only 9 of the 27 cases, however, was pain of any kind complained of, and then it was usually described as of but slight significance. In some patients, however, a tumor of this nature may be the cause of considerable suffering, not only from the sensitiveness of the tumor but also from the mental anxiety with accompanies it.

Discharge from the nipple is not produced by periductal tumors. In only one case of this series was a discharge of any sort discovered, and in that case, a woman who had borne two children, the discharge was milk.

The attempt was made to distinguish between the intracanalicular and pericanalicular types of periductal tumors in regard to their clinical symptoms, but without success. There were four tumors that fell in the pericanalicular group, and three showed the characteristics of both classes, while in the 20 others no marked involvement of the smaller terminal branches could be made out. The clinical appearance of the tumors of the pericanalicular type were not distinguishable from those of the other classes, and the distinction is not, we believe, one of any great significance, although the difference in the histological picture of the two tumors is considerable.

The diagnosis of the periductal fibroma depends upon the following characteristics: It appears in young women, is of slow and almost painless growth. Multiple tumors are not uncommon. It is freely mobile in the breast tissue, has well-defined margins of rounded and lobular outline, and has a consistency which is hard, but often elastic. It is almost never adherent to the skin or to the chest wall, and of course does not cause enlargement of the axillary glands. No discharge from the nipple is produced.

The periductal myxomata and sarcomata are usually larger tumors, and readily undergo degenerative changes causing areas of softening. The skin over them is generally thinned and often stretched so tightly as to appear to be adherent.

The papillary cystadenomata are small tumors, centrally situated, cystic, and may frequently be recognized by the discharge of blood from the nipple. When this symptom is absent (as in about 50 per cent. of cases) the diagnosis from a periductal tumor may be difficult. The cystadenoma, however, occurs more frequently in older women.

The fibrocystadenomata do not differ materially in clinical signs or symptoms from the periductal tumors. In some cases the fibrocystic tumors are of long duration and of larger size, and the recognition of definite elastic or fluctuating cystic areas in the tumor may be suggestive, but, as a rule, the fibrocystadenomata are operated upon as periductal tumors, and recognized only on microscopic examination.

Chronic inflammatory processes in the breast, such as tuberculosis, syphilis, actinomycosis, chronic abscess, and diffuse galactophoritis after lactation, produce less well-defined tumors, are usually adherent to the surrounding tissues, and often show inflammatory changes, and even discharging sinuses. The axillary glands are also frequently involved to a greater or less extent.

Cystic disease of the breast occurs at about the time of the menopause, and produces an induration less well defined than the periductal tumors. Cysts deep in the gland, or surrounded by dense fibrous tissue, may give to the examining fingers a sensation not unlike that of a small periductal tumor in a younger woman. The diffuse and often bilateral character of cystic disease and the greater sensitiveness it produces will usually serve for its recognition.

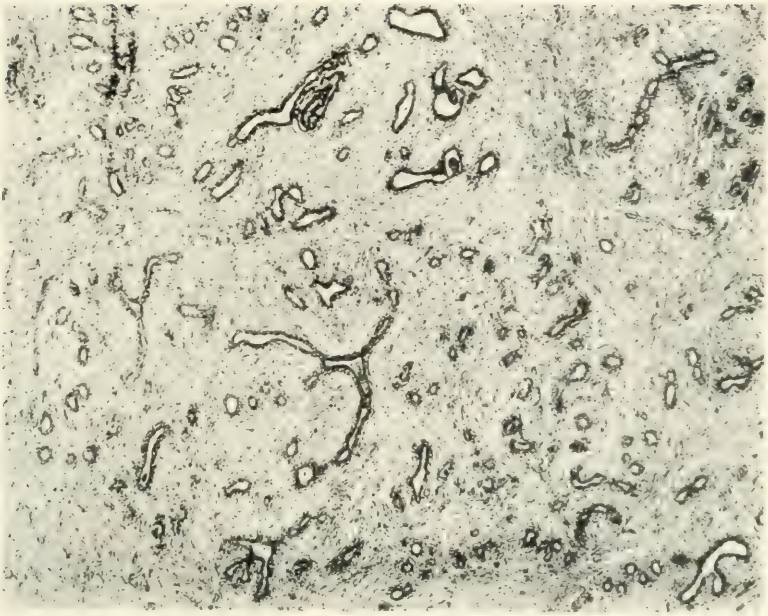
Carcinoma of the breast is distinguished from periductal fibroma by its characteristic symptoms of indefinite outline, early adherence and loss of mobility, and invasion of axillary nodes. Cancer is expected in older women, while the periductal tumor is usually one of earlier onset, although in one case of this series medullary cancer was present in one breast and a periductal tumor in the other at the same time.

Sarcoma of the non-indigenous variety, though a rare tumor in the breast, is more likely to be confused with carcinoma than with other diseases. Its early infiltration and adherence and its rapid growth make the diagnosis of malignancy most probable.

Finally the tumors which are not peculiar to the breast, such as lipoma, enchondroma, angioma, etc., are to be differentiated by their characteristic symptoms, and occur so rarely in this situation as to merit little consideration in differential diagnosis. It is to be remembered, however, that few surgeons are sufficiently expert or sufficiently ready to accept the grave responsibility of depending upon the differential diagnosis of any tumor of the breast, from clinical appearances alone, to advise against operation. No tumor of the breast is innocent or incapable of harm to the patient until it has been removed. The differential diagnosis is of great importance in determining the appropriate treatment, and many a breast could be saved if the establishing of a diagnosis were more carefully attempted—not with the idea of avoiding operation, but with the intention of securing the operative treatment best suited to the individual case.

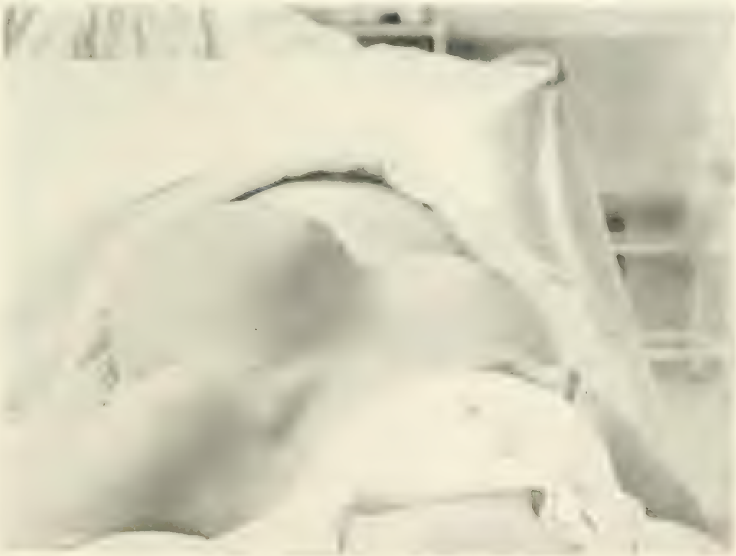
Treatment.—The treatment of periductal fibroma, like that of all other tumors of the breast, is by removal. In some cases of multiple tumors of small size in both breasts, writers

Fig. 4.



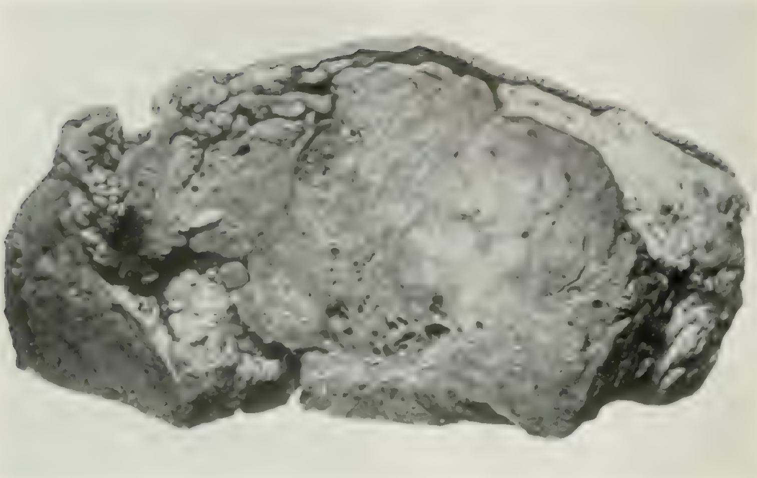
Periductal fibroma. Pericanalicular type. Low power, showing gland ducts only slightly distorted, but separated in stroma of periductal fibrous tissue. Compare with Fig. 2.

Fig. 5.



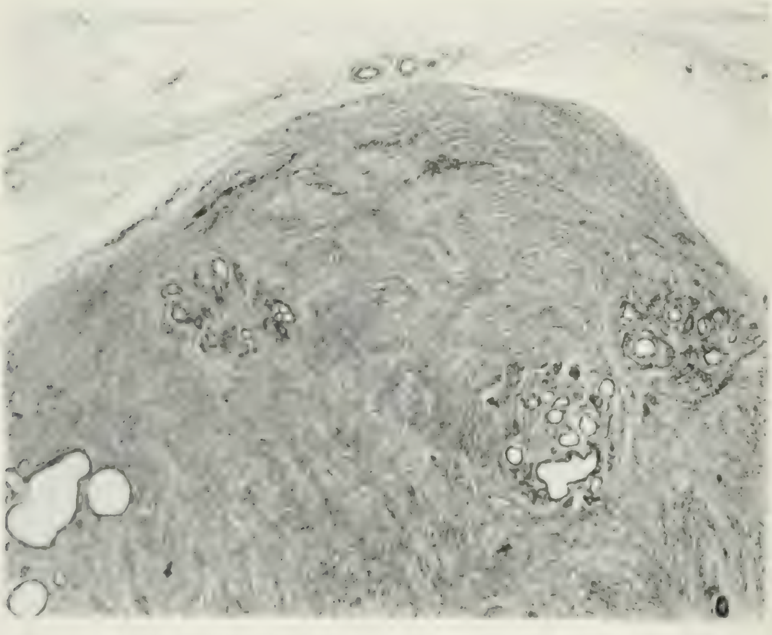
Pericanalicular myxomatous [illegible]. [illegible]

Fig. [illegible]



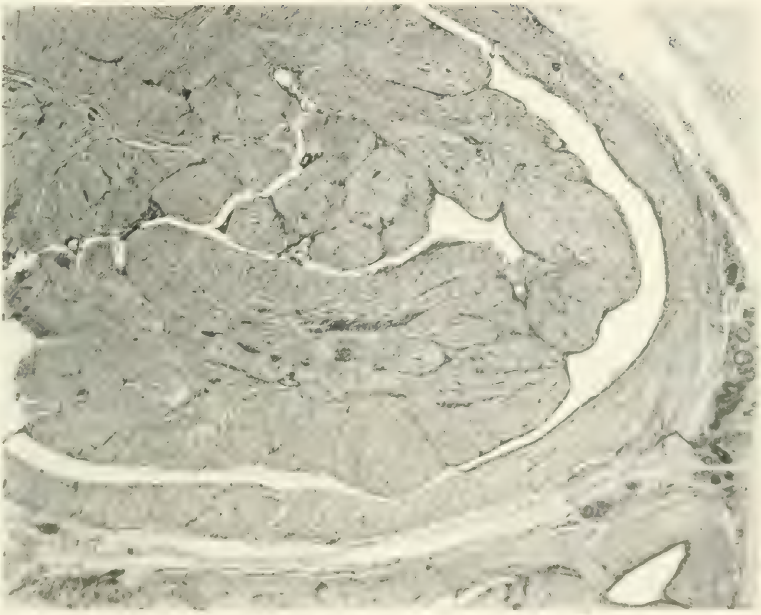
[illegible] [illegible]. Gross appearance of preceding tumor. Note encapsulation, volume of tumor, cysts, and rounded, papillary intracystic projections.

Fig. [illegible]



[illegible] [illegible]. Low power. Portion of tumor showing cell-rich stroma of sar-comatous periductal tissue, gland ducts, and cysts and encapsulation.

FIG 8.



Periductal myxosarcoma. Low power. Portion of same microscopic section as Fig. 7; showing no evidence of sarcoma, but typical periductal fibroma; other portions of this tumor showed typical myxomatous tissue in the stroma.

have advised against operation (Bloodgood), but so extreme a case has not come to our attention. Of this series of 27 cases, in 14 the tumor or tumors were excised through an incision directly over the tumor. In 11 cases a "plastic resection" was performed after the method advocated by Dr. Warren, the tumor being removed from underneath through an incision along the axillary and inferior margins of the breast. In 2 cases amputation was done: once under a mistaken diagnosis, and once because of the large size of the tumor. It is probable that with the exception of the very small and superficial tumors, the "plastic resection" is the operation of choice, as it places the scar in an inconspicuous position and does not add materially to the difficulties of operation: even the largest tumors may be removed by this method, and when the displaced breast tissue is drawn together a fairly respectable looking mamma will result.

PERIDUCTAL MYXOMA AND SARCOMA.

We have been able to collect six cases which can be placed in the myxosarcoma group. If an arbitrary division were attempted, four of these cases would be classed as periductal sarcoma, and two as periductal myxoma. We believe, however, that such a division is unnecessary and undesirable, and that the tumors of this character are best described under the one term "periductal myxosarcoma." They have heretofore been described in medical writings under a variety of different terms —cystic or cystosarcoma, adenosarcoma, fibromyxosarcoma, fibrosarcoma, cystosarcoma phyllodes, etc. The relation they have to the periductal fibromata and their differentiation from the simple or non-indigenous sarcomata, which occur but rarely in the female breast, have not always been clearly drawn. In a series of 658 consecutive cases of breast tumor taken from the records of the Massachusetts General Hospital,[1] there were 459 cases of carcinoma (69 per cent.); 14 of myxosarcoma (2 per cent.); 48 of periductal fibromata (7 per cent.) and 4 of non-indigenous sarcoma (0.6 per cent.). The periductal myxosarcoma, though a rare tumor, is the most common form of sarcoma of the breast.

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[1] Warren, J. C.: Jour. A. M. A., July 15, 1905.

The gross characteristics of the myxosarcoma in the six cases here collected were well defined. Single tumors were present in five cases, and a tumor was present in both the right and left breast in one case. The tumors were of relatively large size, the smallest being 5 cm. in diameter, and the others being estimated as of the size of an apple or orange up to that of a child's head. They practically occupied or displaced the whole breast, so that their situation in that organ could not be determined. The consistency of the tumors was usually described as hard, and the surface as irregularly lobulated; rarely cystic areas were recognizable, in one case a cyst the size of a grape-fruit being present.

Adherence of the skin over the tumor was noted in but two cases, and in one of these there was actual ulceration and an offensive discharge from the necrosing tumor tissue. In several cases, dilated veins over the tumor were recorded.

On section of the tumor, after removal, the usual description was that of a grayish, more or less translucent tissue, in lobular arrangement, with cyst or cleft formation. Complete or partial necrosis of the tissue was present in two cases. Cysts varied in size from microscopic dimensions to one the size of a grape-fruit, the contents being serous or brownish fluid. Papillary outgrowths into a cyst cavity were present in four of the six cases. In four of the six cases definite mention is made of a capsule delimiting the tumor from the breast tissue.

The microscopic sections of these tumors showed a characteristic though varied picture. The stroma of the tumor is composed of more or less cellular connective tissue, separated into lobules by strands of ordinary fibrous tissue. Through the stroma are scattered epithelial-lined ducts, cysts, or clefts. The connective tissue almost always varies in different portions of the specimen, and presents all gradations from the loose, fibrous tissue of the periductal fibroma, through the more cellular myxomatous tissue with stellate cells and delicate processes, up to the richly cellular compact tissue of a fibrosarcoma. Tissues of these different cell characters not uncommonly lie side by side in the same preparation, and it is on this account that the differentiation of the periductal myxoma from the periductal sarcoma is so difficult and, we think, unnecessary. In the more cellular portions of the tumor mitotic figures may be seen. Necrosis and gelatinous or hyaline degeneration of the tissue were common in the larger tumors.

The epithelial structure consists of ducts, clefts, and cysts, lined with one or more layers of epithelium, exactly similar in every way to the epithelial elements of the periductal fibroma. In fact the resemblances of the two groups of tumors, not only from gross and microscopic appearances but from clinical symptoms as well, are such as to force upon the observer the conclusion that the myxosarcoma is a periductal fibroma, the fibrous tissue of which has more or less taken on the change in characteristics (anaplasia) which marks the advance from benign to malignant tumor growth—a change which, whether correctly or not, is often spoken of as " degeneration."

The clinical symptoms of periductal myxosarcoma are fairly well defined. They occur at a period later in life than the periductal fibroma, the youngest of our six cases being 36, the oldest 53, and the average 49 years. Three were in single and 3 in married women, and lactation appeared to be in no way associated with the onset or progress of the tumor. In one case a blow received upon the breast was thought to have occasioned the appearance of the tumor which had not before that time been detected.

The rate of growth of the tumors is comparatively rapid: one tumor in eight weeks grew to be the size of an orange; and another after incomplete removal grew in five weeks to the size of a child's head. In a third case, a small tumor was present for 12 years, but began to grow rapidly five weeks before entrance, and attained a size of 10 x 20 cm. at operation. No retrogression in size was ever noted, and no discharge of fluid from the nipple. In one case the nipple was thought to have been retracted. No pain was caused by these tumors, although the weight of the breast and, in one case, the ulceration caused discomfort. The axillary glands were not noted as enlarged except in one case, where a small, soft gland was felt and removed at operation but no evidence of sarcomatous involvement of it was recorded.

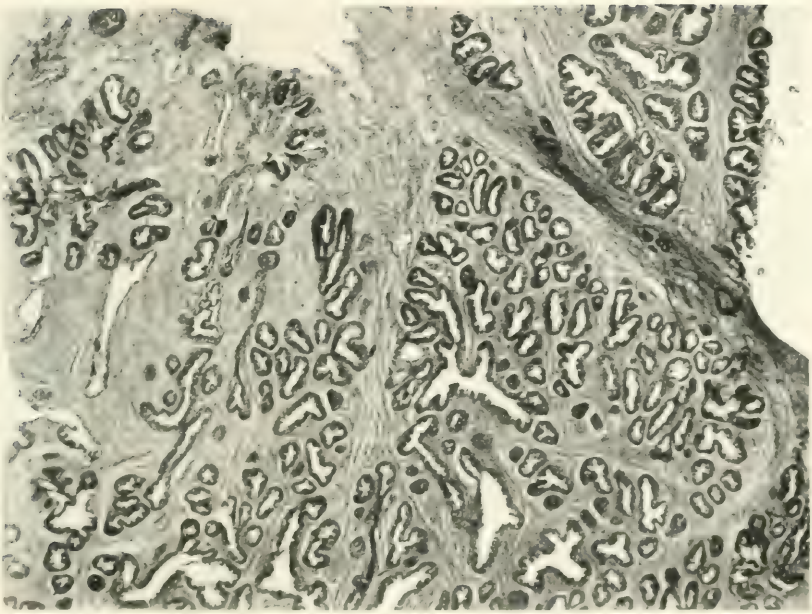
The diagnosis of periductal myxosarcoma should not be difficult. The tumors occur later in life, as a rule, than the fibroma, and are of larger size and more rapid growth. They are encapsulated and non-adherent unless necrosis of the tissue occurs or the skin is stretched and thinned over the tumor so as to favor ulceration. No carcinoma of the breast reaches such a size without its diagnosis being certain from the involvement of the skin and muscles and of the axillary glands.

The treatment should be complete removal of the tumor by amputation of the breast. The axillary contents and the pectoral muscles, however, do not need to be removed. Of the six cases here reported five had amputation of the breast, and in one case an excision was done. The excision is free from recurrence 7½ years after operation. Of the five amputations 2 are dead, one of unknown cause nearly 2 years after operation, one of pneumonia 4 years after operation, when about to undergo operation for a tumor in the other breast, which was thought by her attendant to be a recurrence of the sarcoma although no local recurrence in the scar of the first operation had taken place. Two of the other amputations were well 8 years and 1 year respectively after operation, and of one case no data could be obtained. One of the cases in which amputation was successfully performed had had a tumor the size of a hen's egg (a myxofibroma) excised 3 years before. Thus excision of the tumor without amputation must be considered hazardous, but a complete amputation should be expected to result in permanent relief.

FIBROCYSTADENOMA.

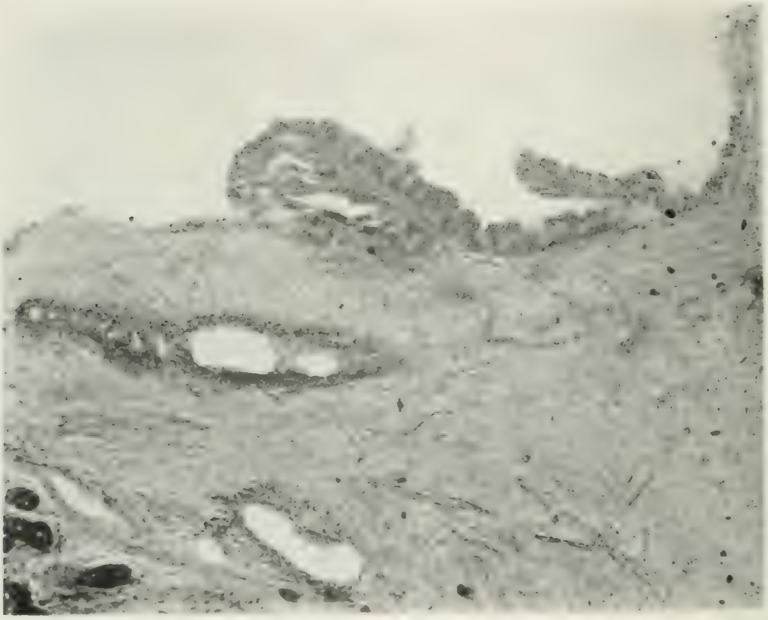
The tumors of this group are what might be termed the epithelial type of the periductal fibromata, and differ from them

Fig. [illegible]



Fibrocystadenoma. Low power, showing large number of gland ducts and cysts in proportion to stroma, and active proliferation of epithelium.

[illegible]



[illegible]. [illegible] [illegible] [illegible] proliferation of epithelium in papillary [illegible] [illegible] only in the relation of the component parts. In the periductal fibromata the epithelial structures of the glands and ducts appear to be passively distorted by the growth of the periductal tissue. The fibrocystadenomata, on the other hand, although showing a growth of periductal tissue, have as their main characteristic a marked hyperplasia of the epithelial elements. A hard and fast line between the two tumors cannot always be drawn, because the diagnosis depends on the impression of the relative activity of the growth of the two component tissues. In fact, it is doubtful whether any special importance would attach to the making of this distinction if it were not for the fact that, because of the predisposition of the breast to cancer, active proliferation of the adult gland epithelium from any other cause than pregnancy and lactation is to be regarded with suspicion.

In the fibrocystadenoma group of the fibroepithelial tumors there were ten cases, in two of which both breasts were affected. In the hospital records these cases had been variously classified and many different pathological names had been applied to them, but in comparing them they all seemed to belong in the same group. Five were diagnosed as fibrocystadenoma. To one the term adenoma had been applied, two were diagnosed as periductal fibroma, one as adenofibroma, and one as intracanalicular papillary myxofibroma.

In gross, the tumors all appeared firm, elastic, well-encapsulated growths, varying in size from 2 cm. to 7 cm. in diameter. They were for the most part roughly round in shape, but the two largest, both over 6 cm. in diameter, were lobulated. In consistency they were described clinically as " hard " six times and twice as " firm," while in the pathological reports they were variously designated as firm, elastic, or fibrous.

On section the tumors had the general appearance of the periductal fibromata. The tissue was firm, fibrous, and usually of a dull white color, although in some cases it was somewhat translucent—this probably being due for the most part to œdema. On the cut surface numerous soft, glistening points representing the ducts and acini could be seen, these being relatively more numerous than in the periductal fibromata. In but one case did the growth in gross show marked slits, then it was intracanalicular in type. In the three largest tumors there were many small cysts, these varying in size up to 1.5 cm. in diameter. In two of these the cysts were filled with clear, straw-colored fluid, while in the third the contents were described as pultaceous.

The chief and characteristic difference of these tumors from the periductal fibromata is the proportionately large amount of epithelium in relation to the fibrous tissue. The epithelium is the tissue which appears to show the most active growth. The tumors have a distinct, dense, fibrous capsule. Within this there is a tendency to a lobular arrangement of the tumor tissue, which is less marked or may be absent in the smaller growths. The stroma is as that of the periductal fibroma—loose, cellular, fibrous tissue without round-cell infiltration, evidently derived from the connective tissue immediately around the ducts. Two chief types of the growth may be distinguished as in the periductal group, *i.e.*, the pericanalicular and the intracanalicular types; of these the former is the more common, and although the two types merge somewhat, one into the other, the suggestion is strong that the periductal fibromata of the pericanalicular type are those from which the fibrocystadenoma is chiefly derived. Cysts lined with one or more layers of epithelium are present more frequently than in the fibroma group, and the ducts themselves have a great variety in appearance. In some cases the glands and ducts seem comparatively normal, but are increased in numbers beyond the conditions found in the normal non-lactating breast tissue. In other cases they are much distorted, while in still other instances the cells lining them show all the characteristic proliferative changes seen in cases of abnormal involution or cystic disease of the breast. Thus, while many glands are lined with a single layer of cuboidal or columnar epithelium, others show a heaping up of the cells forming papillary growths projecting into the lumen, and this process may be so pronounced that the lumen is entirely plugged. The cells may even have an adenomatous arrangement, which is what might be termed the most extreme type of epithelial proliferation, and is similar to that seen in the abnormal involution cases which have a tendency to progress to carcinoma.

The patients varied in age from 15 to 44, the average of the ten being 30.5 years. Five were married and five single, but the records were too imperfect to allow any conclusions to be drawn as to the relation of lactation to the tumors. The length of time elapsing between the discovery of the growth and the seeking of medical advice varied from three months to five years, but the duration bore no relation to the size of the tumor. Thus one tumor of the size of an orange was of only three months' duration, while a tumor the size of a pigeon's egg had been present five years. No mention was made of the tumors varying in size, with the exception of one case in which fluctuation in size was quite marked, but had no relation to menstruation. In this case the change in size was probably dependent on the filling and emptying of cysts which were present in large numbers. In no case was a discharge from the nipple noted.

Five patients complained of pain, and in three cases the pain was neuralgic in character, shooting down the arm (mastodynia). In the other two it was spoken of as "slight." It had no relation to the catamenia. The right breast was the seat of the tumor five times, the left three, while in two cases both breasts were involved. In only one of these two, however, were both breasts operated upon, and in this case, while one of the tumors was a typical fibrocystadenoma, the other could best be classified in the periductal group. The tumors occupied any position in the breast, and varied in size up to that of an orange. They were freely movable over the deeper parts, and not adherent to the skin even when of large size. In but two cases was the presence of enlarged axillary glands noted.

It is practically impossible to differentiate between the periductal fibromata and the fibrocystadenomata clinically. The average age of the patient, the rapidity of the growth, and the portion of the breast involved are the same. Neither is adherent, nor are enlarged glands usually present in the axilla. In a few of the larger tumors it may be possible to palpate the cysts if any are present, and thus establish the diagnosis, but true fluctuation in small breast cysts is extremely difficult to determine. For the differentiation of the fibrocystadenomata from the tumors of the breast other than the periductal fibroma, the reader is referred to the differential diagnosis of the fibromata given above. The treatment also is that of the periductal fibroma, that is, excision of the tumor, performed when possible by the "plastic resection" method. The prognosis is, of course, favorable, and no recurrence will take place after thorough removal.

SUMMARY.

A comparative study of the fibro-epithelial tumors of the breast shows that their relations one to another are very close, and justifies their being grouped together as in the Warren classification. The essential feature of the tumors of the fibrous type is the presence of periductal fibrous tissue in more or less abundance about the gland ducts. This periductal tissue may vary in cell richness from normal fibrous tissue to myxomatous or sarcomatous tissue. The two types of tumor, however, with this exception are so much alike that the sarcoma type may be well considered merely a modification of the benign fibroma. The periductal fibroma needs only excision of the tumor to effect a cure. For the periductal myxosarcoma, amputation of the breast is advised, without removal of the muscles or dissection of the axilla; the tumor is only locally malignant.

The fibrocystadenoma group includes a few tumors of similar origin to the foregoing, which display, when examined by the microscope, a tendency to epithelial overgrowth. The diagnosis between fibrocystadenoma and periductal fibroma cannot be made with certainty before the removal of the tumor. This tendency to epithelial proliferation is encountered in other diseases of the breast, such as abnormal involution of cystic disease; and is an undoubted source of danger to the patient in adult life. For this reason, complete removal of any fibro-epithelial tumor of the breast by early operation is the best treatment to be advised.

ABSTRACT OF CASES.

Periductal Fibroma.

Case G. (562-241.) Dr. C. L. Scudder.—21, single. History deficient. Small fibrous tumor of breast removed at operation for appendicitis. *Mx.* irregularly dilated ducts, flattened epithelium, slit cysts. Periductal fibroma.

Case H. (CXLII., 49.) Dr. F. G. Balch.—25, single. 7 years' duration. Pain, especially at cta. Size marble, lower outer quadrant right breast. Non-adherent, excised. Two small nodules, myxomatous (œdematous) fibrous tissue with cavities. Intracanalicular type. Periductal fibroma.

Case F. (526-221.) Dr. R. B. Greenough.—23, married, children, long duration, no pain. Entrance diagnosis, fibroma. Two tumors outer hemisphere left breast, size of orange and chestnut. Hard, not tender, non-adherent. Plastic resection. Two lobulated nodules, few cysts, pericanalicular type. Some epithelial proliferation. Periductal fibroma.

Case D. (516-21.) Dr. R. B. Greenough.—31, widow. 4 weeks' duration, no pain. Patient had left breast amputated for carcinoma 6 months previous. Nodule size of chestnut, outer hemisphere right breast. Hard, non-adherent, not tender. Excised. Tumor 8 x 3 cm., encapsulated, myxomatous with clefts. Intracanalicular type. Clefts lined with single layer epithelium. Œdematous fibrous tissue. Periductal fibroma.

Case 161. (XLVII-124.) Dr. W. M. Conant.—26, single, six months', no pain. Tumor size of large bean, right breast, upper inner quadrant, not tender, non-adherent. Similar tumor removed from right breast three years before. Excision. Fibrous tumor, white, hard. Mx. shows few ducts and cysts. Intracanalicular type. Papillary fibroma.

Case 42. (398-138.) Dr. J. C. Warren.—35, single, six months, slow growth, no pain, left breast, size of walnut, upper outer quadrant, not tender or adherent. Excised. Encapsulated tumor, gray, with slit cysts. Intracanalicular type, œdematous fibrous tissue. Periductal fibroma.

Case 113. (449-55.) Dr. S. J. Mixter.—27, single, 10 years, slow growth, tumors both breasts, size of small egg and smaller, hard, non-adherent. Excised. Tumors firm, white, with slit cysts. Intracanalicular type. Periductal fibroma.

Case 185. (LXXXIII-211.) Dr. H. H. A. Beach.—19, single, 1 year, slow, fluctuation in size, slight pain. Tumor size of hen's egg, right breast, hard, non-adherent, not tender. Excised. Encapsulated lobulated tumor, fibrous, with slit cysts. Intracanalicular type. Slight epithelial activity. Periductal fibroma.

Case P. (537-379.) Dr. J. G. Mumford.—38, married, three children, eight months, slow growth, slight pain. Tumor size orange, centre, right breast. Slightly tender, non-adherent. Amputation. Encapsulated tumor, translucent, gray, slit cysts, œdematous fibrous tissue, few small cysts. Periductal fibroma.

Case 200. (480-107.) Dr. C. L. Scudder.—37, married, two children, five months, no pain. Tumor size of orange, centre right breast, hard, nipple exudes milk, both sides, non-adherent. Amputation. Encapsulated tumor, firm, translucent, gray, slit cysts. Intracanalicular type. Periductal fibroma.

Case 180. (LXXV-243.) Dr. A. T. Cabot.—36, single, ten months, no pain, tumor size of horse chestnut. Lower hemisphere left breast. Hard, non-adherent. Excised. Encapsulated tumor, fibrous, with slit cysts. Intracanalicular type. Periductal fibroma.

Case 112. (423-93.) Dr. H. H. A. Beach.—27, single, 1½ years, slow growth, no pain. Right breast, inner hemisphere. Tumor 2 inches in diameter. Soft, non-adherent. Amputation. Fibrous tumor with irregularly dilated ducts and slit cysts. Intracanalicular type. Periductal fibroma.

Case 93. (375-186.) Dr. M. H. Richardson.—38, married, three months, slight pain, left breast, upper outer quadrant, size of walnut, hard, slightly tender, non-adherent. Excised. Several fibrous nodules in breast showing increase of fibrous tissue and proliferation of gland ducts. Pericanalicular type. Periductal fibroma.

Case 34. (388-54.) Dr. J. W. Elliot.—29, married, seven children, seven years' duration, slow growth, slight pain, two tumors size of walnut upper hemisphere right breast, hard, non-adherent. Resection. Three discrete fibrous tumors in substance of gland. Intracanalicular and pericanalicular in different areas. No epithelial proliferation. Periductal fibroma.

Case 196. (CIII-99.) Dr. W. M. Conant.—52, married, two children, one year's duration. Slow growth, no pain. Tumor 3 x 5 cm. upper outer quadrant left breast, hard, non-adherent. Partial excision. Tumor encapsulated, marked papillary construction. Intracanalicular type, slit cysts. Periductal fibroma.

Case 214. (LXIX-153.) Dr. C. B. Porter.—17, single, six months, slow growth, no pain. Tumor size of walnut, lower outer quadrant right breast. Hard, non-adherent. Excised. 2 cm. Tumor white, fibrous, slit cysts. Intracanalicular type. Periductal fibroma.

Case 212. (140-504.) Dr. J. C. Warren.—40, married, four children, 1 year, pain. Tumor size of pigeon's egg, right breast, upper outer quadrant. Hard, tender, non-adherent. Excision. Two tumors, encapsulated, gray, firm, slit cysts. Intracanalicular type. Periductal fibroma.

Case 208. (492-151.) Dr. J. C. Warren.—35, single, one year, slow growth, no pain. Tumor size of walnut, inner hemisphere right breast. Not tender or adherent. Excision. Encapsulated nodule, slit cysts. Intracanalicular type. Periductal fibroma.

Case 210. (492-269.) Dr. J. C. Warren.—32, single, three months' duration, no pain. Tumor size of hen's egg, upper inner quadrant right breast. Not tender or adherent. Excision. Firm fibrous tumor, slit cysts. Intracanalicular type. Slight activity of epithelium. Periductal fibroma.

Case E. (CXXI-27.) Dr. H. H. Beach.—27, single, two years, no pain, left breast, outer hemisphere. Tumor size of egg, hard, slightly adherent (?). Excised. Flat oval tumor, lobulated, fibrous consistency. Pericanalicular type. Myxomatous connective tissue, no cysts. Periductal fibroma.

Case I. (570-83.) Dr. L. Davis.—15, single, 1 year, pain slight, tumors in both breasts, hard, 1 and 2 inches in diameter, non-adherent. Excised. Fibrous tumors with slit cysts. Intracanalicular type. Periductal fibroma.

Case M. (530-213.) Dr. M. H. Richardson.—33, married, 1 child, 3-4 years, no pain. Tumor size of orange, upper inner quadrant left breast. Hard, non-adherent. Excision. Two encapsulated tumors, gray, fibrous, slit cysts. Intracanalicular type. Periductal fibroma.

Case T. O. P. D. (133-190.) Dr. L. Davis.—19, single, two months, tumor size of walnut, upper inner quadrant left breast, non-adherent. Excision. Fibrous encapsulated tumor, 2 x 3 cm., lobulated. Intracanalicular type.

Case B. O. P. D. Dr. C. C. Simmons.—26, single, 1 year's duration, no pain, size of hen's egg, lower outer quadrant right breast, hard, non-adherent. Excision. Encapsulated tumor, fibrous, lobulated. Intracanalicular type, few cysts. Periductal fibroma.

Case Q. (596-133.) Dr. F. B. Harrington.—27, married, 1 year's duration, slow, slight pain. Tumor size of walnut, lower outer quadrant left breast, hard, non-adherent. Excision. Tumor encapsulated, 2 cm., nodular, myxomatous connecting tissue. Pericanalicular type. Periductal fibroma.

Case R. (CLVIII-129.) Dr. J. G. Mumford.—25, single, two years' duration, no pain. Tumor 1 inch in diameter, inner hemisphere left breast. Hard, lobulated, non-adherent. Excision. Encapsulated, lobulated growth, white, firm. Intracanalicular type, few small cysts. Periductal fibroma.

Case C. (503-251.) June, 1905. Dr. H. Williams.—17, single, eight weeks, some diffuse pain. Tumor size 3 inches, left breast, outer hemisphere, nodular, non-adherent. Excision. Encapsulated tumor, gray, white, slit cysts. Very cellular fibrous tissue. Intracanalicular type.

Periductal Myxosarcoma.

Case K. (561-121.) Dr. S. J. Mixter.—52, single, seven months' duration, following a blow, no pain. Tumor size of apple in central portion of left breast, hard, skin slightly adherent, veins dilated, no axillary glands. Amputation. Encapsulated, semi necrotic, grayish tumor. Mx. shows spaces surrounded by cellular myxomatous tissue, epithelium of ducts degenerated. Periductal myxo-sarcoma. No recurrence one year later.

Case 94. (381-208.) Dr. S. J. Mixter—40, married, three months' duration, no pain. Tumor size of walnut lower outer quadrant right breast, non-adherent, no glands. Excision. Lobular tumor, gray, translucent

Minute cysts. Mx. shows cellular stroma with scattered epithelial tubules. Adeno-sarcoma. No recurrence eight years later.

Case 172. (LXVII.) Oct. 28, 1902. Dr. C. B. Porter.—53, single, twelve years' duration, rapid growth, 5 mos., no pain. Tumor size child's head, occupying left breast, non-adherent, no glands. Amputation. Encapsulated tumor, gray, gelatinous, with clefts. Mx. shows cellular myxomatous and sarcomatous tissue interspersed with gland ducts. Intracanalicular type. Periductal sarcoma. No recurrence one year later, died three years later of pneumonia. ? of tumor in other breast.

Case 178. (LXXIII-65.) Dr. A. T. Cabot.—51, married, 4 years' duration, slow growth, slight discomfort. Tumor 23 cm. in diameter, occupying left breast, ulcerated and skin adherent, dilated veins, no axillary glands. Amputation. Large tumor, gelatinous, lobulated, slit cysts. One large size cyst size of egg with papillary outgrowths, cellular fibrous and myxomatous tissue. Periductal myxoma-sarcoma. Patient died two years later, cause unknown.

Case 216 (XXXIII-45.) Dr. J. W. Elliot.—40, married, 1 child, tumor 8 weeks' duration, rapid growth. Tumor size orange, middle right breast, hard, non-adherent, one small axillary gland. Amputation with dissection of axilla. Encapsulated tumor 5 cm. in diameter, lobular, grayish, translucent. Mx., myxomatous tissue and gland ducts with some proliferation of epithelium. Periductal myxo-sarcoma.

Case 159. (XLVII-74.) Dr. W. M. Conant.—36, single, 4¼ years' duration. Tumor left breast, size hen's egg. 3½ years ago tumor in right breast size child's head. Operation three years ago. Amputation of right breast. Excision of left. Diagnosis: myxo-fibroma. Five weeks ago tumor developed in left breast, rapid growth, now size child's head, skin not adherent but discolored. Amputation. Encapsulated tumor with gelatinous tissue and cysts with brownish fluid and papillary projections. Periductal myxo-sarcoma. No recurrence 8 years later.

Fibrocystadenoma.

Case 50. (452-153.) Dr. C. L. Scudder.—38, married, 5 months' duration, slow growth, some pain. Tumor size of orange, inner lower quadrant right breast, hard. Excision. Encapsulated fibrous tumor, pearly-colored tissue, slit cysts. Mx. shows loose fibrous tissue, œdema (?), with active epithelial proliferation in cysts. Fibrocystadenoma.

Case 179. (LXXIII-187.) Dr. A. T. Cabot.—25, married, 4 years' duration, no pain, 4 tumors in right breast each about size of walnut, one tumor in centre left breast size lemon, non-adherent. Tumor on left excised. Fibrous tumor 4½ cm. with small cysts. Mx. shows much proliferation of epithelium. Fibrocystadenoma.

Case L. (523-85.) Dr. M. H. Richardson.—29, widow, 1 year, little pain, upper outer quadrant right breast, tumor size of orange, firm. Excision. Encapsulated tumor, œdematous, firm, with many cysts, loose fibrous tissue with active proliferation of glandular epithelium. Fibrocystadenoma.

Case N. (CXXVI-273.) Dr. F. G. Balch.—42, widow, 2 years' duration. Tumor size pigeon's egg upper outer quadrant right breast, non-adherent. Excised. Fibrous tumor 4 cm. in diameter, œdematous fibrous tissue, proliferation of epithelium in ducts. Small cysts. Pericanalicular type. Fibrocystadenoma.

Case 213. Dr. Torrey, June 28, 1902.—16, single, 8 months. Tumors in both breasts, one 2½ the other 3 cm. in diameter, hard, non-adherent. Excision. Both encapsulated tumors, white fibrous tissue and cysts. Active proliferation of epithelium, papillary projections. Fibrocystadenoma.

Case A. O. P. D. April 18, 1908. Dr. C. C. Simmons.—19, single, 5 years. Tumor size pigeon's egg upper hemisphere right breast, hard, non-adherent. Excision. Nodular, encapsulated tumor. Fibrous tissue, active proliferation of epithelium in cysts and ducts. Fibrocystadenoma.

Case S. (CLVII-129.) Dr. R. B. Greenough.—18, single, 1 year's duration. Slight pain. Tumor size egg lower hemisphere right breast, firm, non-adherent. Excision. Lobulated fibrous tumor. Active proliferation of duct epithelium and of periductal fibrous tissue. Pericanalicular type. Fibrocystadenoma.

Case O. (546-33.) Dr. C. L. Scudder.—44, single, 2 years' duration. Tumor size of horse chestnut, lower inner quadrant left breast, hard, non-adherent. Excision. Encapsulated tumor, hard, lobulated, gelatinous appearance. Myxœdematous fibrous type, with dilated and distorted ducts and active epithelial proliferation. Small cysts. Pericanalicular type. Fibrocystadenoma.

Case 104. (397-145.) Dr. M. H. Richardson.—36, single, 2 years' duration. No pain. Upper outer quadrant left breast. Tumor size of silver dollar, hard, non-adherent. Excision. Lobular tumor, circumscribed. Large epithelial ducts. Active proliferation.

Case X. Dr. H. Cabot, December 16, 1906.—38, married, 2 years' duration. Considerable pain. Tumor central in right breast, size of orange, hard, non-adherent. Excision. Lobulated tumor, encapsulated, circumscribed tissue. Small cysts. Ducts with epithelial proliferation. Fibrocystadenoma.

INTERCOSTAL DIAPHRAGMATIC HERNIA

WITH REPORT OF A CASE.

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THE occurrence of diaphragmatic hernia is not uncommon,[1] but even in the most recent literature on this subject little if any mention is made of its intercostal variety. The following case, therefore, seems to be of sufficient interest to justify its publication.

James McN., thirty-eight years old, single, a longshoreman, always enjoyed good health. He came to the Surgical Department of the University and Bellevue Hospital Medical School Clinic on December 13, 1910, for treatment of an infected abrasion of the right knee. By chance, a tumor of the left side of his thorax was observed. On being questioned about this, he stated that three years before, while working at a sawing table near a circular saw, he was hit on the left side of his chest by the end of a one-inch plank. He felt weak and was laid upon the floor, but did not lose consciousness. A doctor told him that he had a broken rib, but did not strap it. The patient stated that shortly after the accident he was "black and blue" on the left side, from the sternum to the vertebral column, and from the clavicle nearly to the pelvis. Treatment consisted in application of a salve and a bandage. After the ecchymosis began to fade, he noticed a painless tumor upon the left side, which never bothered him.

At no time had there been hæmoptysis, dyspnœa, vomiting, colic, or, in fact, any untoward symptoms. He had not noticed any progressive enlargement of the tumor since its first appearance.

Physical examination showed a large, well-built man, well nourished, in good general condition, in whom the findings were negative except for: (1) a superficial granulating wound of the right knee; (2) a painless, tensely distended bursa in front of the right ligamentum patellæ; and, (3) a painless swelling of the left chest wall, the size of half an apple, situated in the anterior axillary line, near the free border of the ribs (Fig. 1). This enlarged on coughing to a maximum size, 9 cm. long, 7 cm. wide, by 4 cm. thick (Fig. 2). The overlying skin was normal and freely movable. The tumor was entirely reducible through a gap in the thoracic wall between the eighth and ninth ribs, which measured 4 cm. long, 1 cm. wide, and could be closed by the tips of three fingers; its lower end was 4 cm. above the free border of the ribs (Fig. 3). No callus could be made out. Reduction occurred with greatest ease when the patient lay on his right side. The swelling then remained absent except upon straining or coughing. It reappeared a little upon each deep inspiration, and could also be made to appear by manual pressure upon the abdomen. The tumor appeared and remained present as soon as the patient took any position except that just mentioned (lying on right side).

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[1] A. Salomoni (Clin. Chirurg., 1910, Nos. 5 and 6) mentions 1000 cases of diaphragmatic hernia, 50 of which were operated upon.

At times reduction was accompanied by a gurgle. As just mentioned, the tips of three fingers closed the gap in the thoracic parietes; while two fingers could penetrate to a depth of 2 cm. (see X-ray plate, Fig. 5).

In the course of palpation the impression gained was, that omentum first came into the sac, forming its superficial contents, and behind it, especially upon maximum protrusion, came intestine. The percussion note over the hernia was identical with that obtained over the adjacent portion of the abdomen, quite distinct from the pulmonary resonance, which could be obtained just above its upper margin.

Auscultation revealed occasional gurgling intestinal noises. There was absence of vesicular sounds. No sounds were heard over the hernia while the patient was drinking.

From these findings it was concluded that the gut in the hernia was either a part of the transverse colon close to the splenic flexure, or part of the jejunum. Inflation per rectum was not done for fear of thereby losing the patient's attendance at the clinic.

Attempts were made to ascertain the exact nature of the hernial contents by administration of bismuth meals and bismuth enemata, but, owing to the unreliability of the patient, it was impossible to obtain exposures at suitable times. In spite of these unavoidable gaps in the X-ray examination, some of the plates are of interest. Fig. 4 shows the hernia protruded. The difference in density between hernia and lung is very apparent. Fig. 5 shows two fingers inserted as deeply as possible through the defect in the thoracic wall between the eighth and ninth ribs.

The plates were made in the Gibbs Memorial X-ray Laboratory of the University and Bellevue Hospital Medical School, by the director, Dr. L. T. Le Wald, for whose valuable co-operation in the study of this case, I wish to express my gratitude and appreciation.

The patient does not desire an operation, stating that the hernia has never bothered him and that he does not believe it has grown any larger since its first appearance.

In view of his careless habits, I have not advised the wearing of any type of belt or supporter, believing that with his mode of life such an appliance might readily lead to strangulation.

In searching the literature, I found an excellent résumé of the subject by Alquier,[2] who collected nine cases. An abstract of these follows.

I. Cloquet, *Nouveau Journal de Médecine*, December, 1819. A soldier, 35 years old, was run over by a piece of artillery at the battle of Lützen. The wheel passed over his lower thorax and upper abdomen. He was sick and miserable for seven years; finally, in 1815, came under the observation of Cloquet.

A tumor, the size of a nut at first, which had later enlarged to the size of an egg, lay in the space between the left eighth and ninth ribs at their junction with the costal cartilages. It was irreducible and painful. Any bodily activities resulted in an enlargement of the tumor, and these, or any attempts at reduction, caused nausea, vomiting, and intense colicky pains. The man led a miserable existence. What became of him was not recorded.

II. Cruveilhier in his *Anat. Path. Générale*, liv. xxi, Pt. iii, describes a "hernie intercostale traumatique abdominale" in a soldier 70 years old, who had received a blow from a wagon tongue upon the left side of the thorax some years previously. A swelling, the size of a fist,

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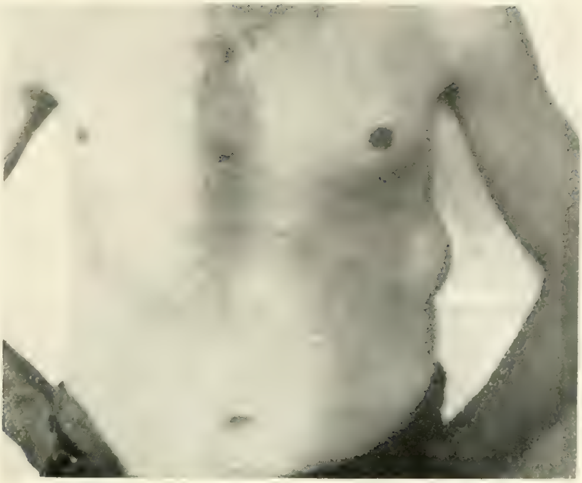
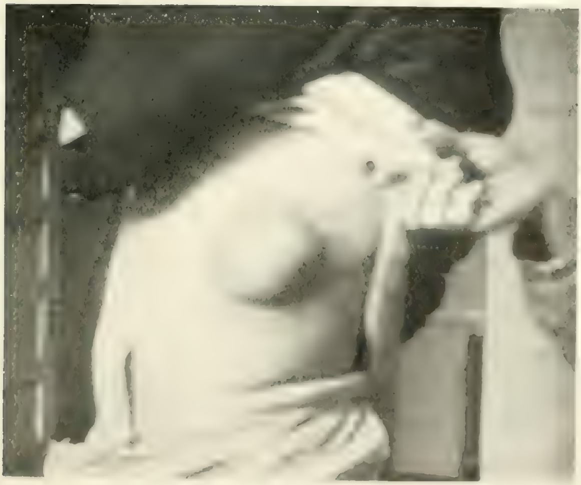
[2] Paul Alquier: "La Hernie Intercostale Abdominale," Thèse de Paris, 1905-6.

FIG. 1.



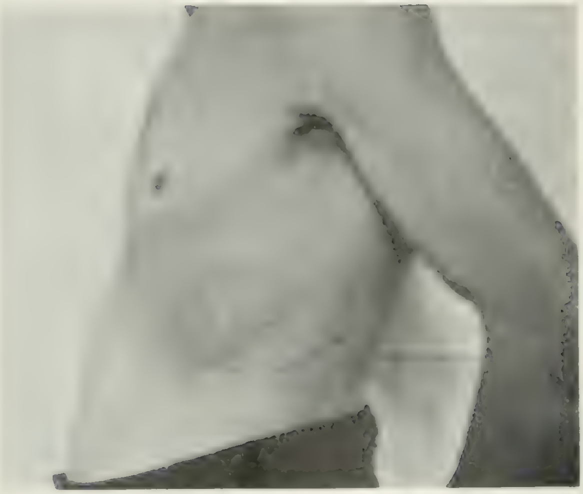
Shows the usual size of the hernia.

FIG. 2.

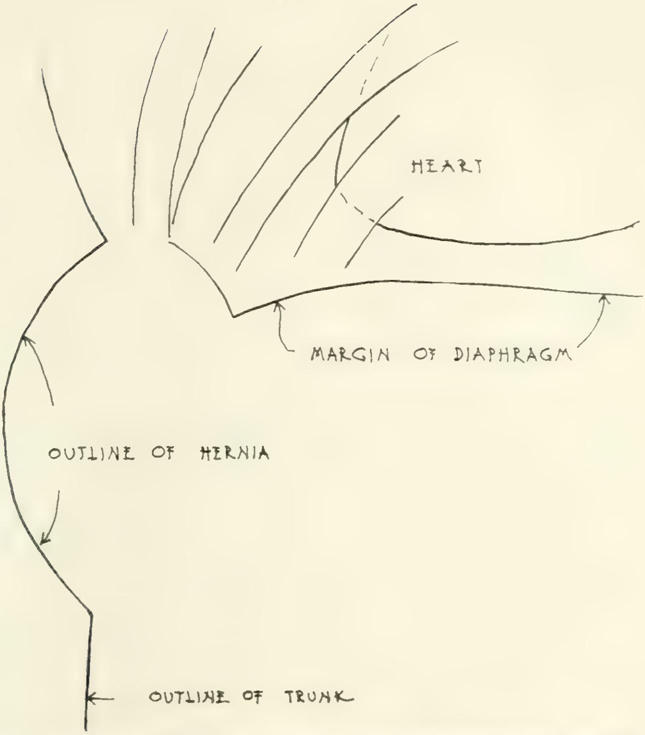


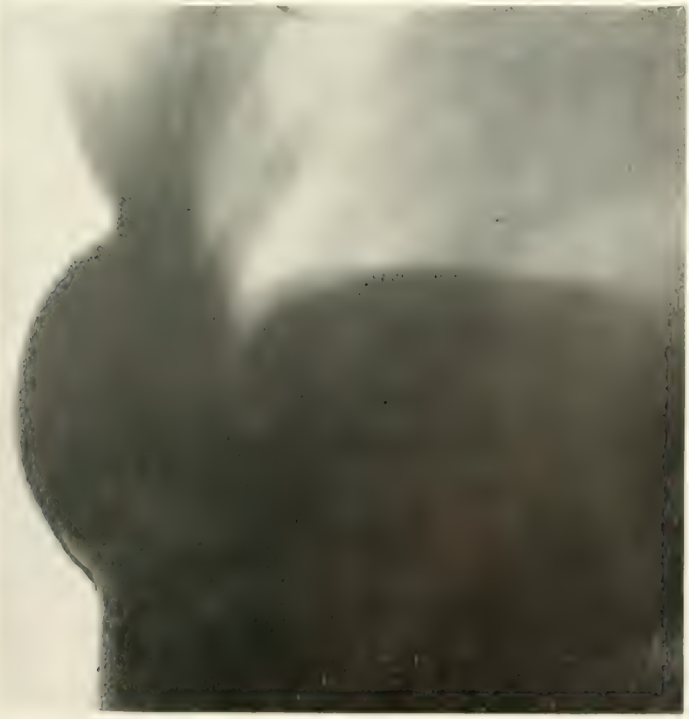
Shows the hernia at its maximum protrusion.

[illegible]



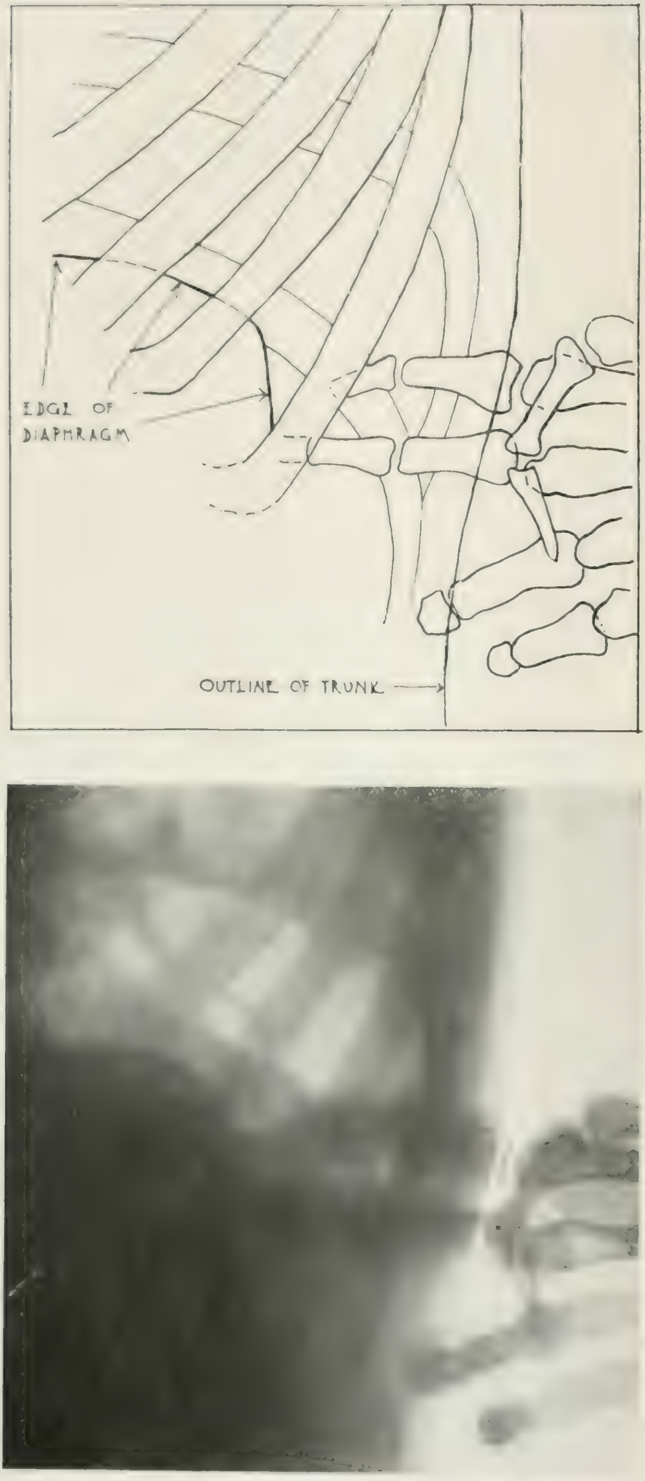
The [illegible] and ninth ribs are indicated by pencil marks on the skin.





[illegible] transversely

Fig. 5.



[illegible]

lobulated, with a sessile base, irreducible but varying in size, was noted at the site of injury upon the left thorax, close to the costal margin. The man died of cirrhosis of the liver in 1828.

At autopsy the lobulated tumor was shown to have a fibrous pedicle, located in the space between the left eighth and ninth ribs. The sac was found to contain omentum adherent to all its recesses, which were represented externally by the lobulations. The intercostal diaphragmatic opening easily admitted the index finger. Close to this opening were stomach and splenic flexure, evidently ready to enter.

III. Risel in the *Deutsche Zeitschrift f. Chir.*, Dec., 1875, Bd. vi, Hft. 3, p. 305, reports the case of a patient, 35 years old, who, in a fit of despondency seven months previously, had attempted suicide by repeatedly stabbing himself with a small blunt knife. The wounds healed, but later herniæ developed in the scars. One in the seventh left interspace, evidently contained omentum and gut, while one in the sixth interspace, was thought to contain stomach. An attack of bronchitis had caused rapid enlargement of the herniæ. No operation was done.

IV. Bazy's case was published by Iselin in *Gazette hebdomadaire de Med. et Chir.*, 1898.

A journalist, 26 years old, had been caught between two colliding wagons on Oct. 1, 1897. He sustained a contusion of the lower thorax and upper abdomen. An extensive ecchymosis immediately developed. Fifteen minutes after the accident a tumor appeared, which increased in size upon making the slightest effort. Hæmaturia lasted for some time, but finally ceased. He wore a belt on account of the tumor, but, because the apparatus became bothersome, he entered the hospital of St. Louis on March 12, 1898.

Examination showed a scar at the level of tenth rib. The tumor on coughing enlarged to the size of an ostrich egg. It was painless, tympanitic, and totally reducible. Upon reduction, the opening was found in the tenth space, extending from its anterior end, back to the midaxillary line. By introducing the hand through this hole, the under surface of the diaphragm could be palpated.

The operation by Bazy was done on March 17, 1898. A 15 cm. incision was made corresponding to the long axis of the tumor. Beneath the skin lay a fibrous sac. On dissecting through this, the colon was accidentally opened. The opening was closed by suture. Careful dissection was then continued close to, and denuding the tenth and eleventh ribs until the peritoneal cavity was finally opened (the hernia evidently was then reduced), and the opening closed by a catgut suture. The tenth interspace was then obliterated by approximating the adjacent ribs by means of two catgut sutures passed through the ninth and eleventh spaces. Layer suture of the rest of the wound was made. An uneventful convalescence ensued. In place of the former hiatus, there was "un véritable plastron osseux." The patient was discharged cured, April 13, 1898.

V. Prat, in the *Archives de Médecine naval*, Oct., 1885, reported the case of a man who, five years previously, while lifting a wagon, had felt a sudden sharp pain in the left side. He did not stop work. There was no hæmoptysis. Five days later a tumor the size of a pea appeared. This gradually increased in size and began to be inconvenient.

On June 25, 1885, the tumor had grown to the size of a hen's egg (6 cm. x 3 cm.). It was situated in the ninth left space, 5 cm. from the free border of the ribs. The tumor's volume increased on deep inspiration. The tumor was irreducible, but gave an impulse on coughing. It was tympanitic on percussion.

For the past three years the patient had suffered from irregular attacks of vomiting, accompanied by pain at the site of the tumor. There were also attacks of diarrhœa, not associated with the vomiting. Prat believed the case to be a hernia of the transverse colon and anterior margin of the stomach, causing a partial obstruction of the colon. No operation.

VI. **Durand**, at a meeting of the *Société de Chirurgie de Lyon*, Aug. 7, 1904, presented a man, who was stabbed in the left side on April 27, 1903. The wound was located in the axillary line between the ninth and tenth ribs, admitted three fingers, and contained prolapsed omentum. There was no operation at that time. He made a smooth recovery.

One year later, April 27, 1904, he entered the hospital on account of a hernia in the scar. The mass was the size of a fist and gave an impulse on coughing. Reducibility and size of opening not mentioned.

X-ray (Destot) showed that the costophrenic space was obliterated at the level of the wound, and that the free pleural cavity was well above the proposed field of operation. At operation it was found that the hernia contained some omentum, which was resected. The transverse colon was pulled up into wound and again replaced. Layer suture of diaphragm, intercostal space, and skin. Recovery.

VII. **Destot**, at the same meeting, reported a case of Giverdey's, of a stout man in whom a hernia had appeared after coughing. It was located between the eighth and ninth ribs upon the left side. The size varied. Auscultation over the hernia revealed the presence of borborygmi, and, when the patient drank, splashing sounds. Inflation under the X-ray confirmed the diagnosis, that the hernia contained part of the stomach. The patient was made comfortable with an elastic belt.

VIII. **Savariaud**, *Soc. de Chir.*, Dec., 1905.

In 1898 the patient, a truck driver of 41, was driving a vehicle which collided with an obstacle and rebounded violently.

He did not fall, but experienced a cracking sensation across the small of his back, followed by a sharp pain there. The man rested three months, but even then was unable to resume active work on account of pains in the back.

These pains occurred in crises of great severity, lasting from a few minutes to several hours. They were relieved by local blistering. The patient saw a number of physicians, who regarded his case as one of traumatic hysteria.

Savariaud found a reducible tumor the size of a mandarin orange in the tenth left space in the axillary line. It enlarged and gave an impulse on coughing. On further questioning, the patient stated that the sharp prow of a boat had struck him there when a child, but he had never paid any attention to the site of injury.

Operation was performed Nov. 22, 1904. After incising the skin, the tumor was found composed of reddened fat distinct from the subcutaneous fat and covered with a cellular fibrous envelope. This fat proved to be omentum. The opening lay in the space between the tenth and eleventh ribs. There was a rudimentary sac around the orifice. The omentum was resected, revealing the spleen at the hernial orifice. A plastic closure of the orifice was effected by using part of the latissimus dorsi. Uneventful recovery.

IX. SCALZI (*Gazette medicale Italo Lombarde,* 1881) reported the case of a man who in 1870 had received 15 stab wounds. One of these, directed from above downward, had divided both eighth and ninth left ribs and perforated the abdomen; it was 5 cm. long. Through this wound a loop of intestine protruded, which was inflamed and distended to the size of an adult fist. The wound was enlarged 2 cm. and reduction of intestinal loop, first into the thorax and then into the abdomen through the diaphragm, was accomplished. The diaphragmatic and intercostal wounds were sutured, an appropriate bandage to lessen thoracic movements was applied, and the patient was kept lying on the left side. He recovered. There was no general reaction, and only a slight local pleurisy.

A hernia gradually developed in the scar. The hernia measured 10 cm. wide by 10 cm. long by 4 cm. high. It was tympanitic, painless, and entirely reducible. There were no symptoms referable to the digestive or respiratory tracts. The man was enjoying excellent health. He drank and ate heartily, and weighed about 250 kilogrammes! (?)

Besides the foregoing cases of Alquier, I have found four more, which are abstracted below.

X. "Medical and Surgical History of War of the Rebellion," Surgical Volume, Part I, p. 515.

Captain R. S., Co. A, 29th N. Y. Volunteers, received a gunshot wound at the battle of Chancellorsville on May 2, 1863. The ball entered the eighth left space, fracturing the ninth rib. The wound was 9½ inches to the left of the ensiform process. There was a hernia of the lung.

Five days afterward (May 7) the ball was voided at stool.

The patient made a good recovery and carried his pneumocele without discomfort.

Sept. 19, 1865, he began to have an irritable stomach, vomiting easily, etc.

March 14, 1867, a sudden enlargement of the tumor occurred while the patient was undergoing exertion. The tumor was partly reducible and borborygmi were noted over it. A pad was worn with good effect, so that in 1872 the tumor was much smaller, firm, and solid

Addendum.—Through the kindness of Dr. W. H. Hartzell of Allentown, Pa., I was able to learn that Captain S. died on August 20, 1893. His widow states that he suffered very much in his later years owing to adhesions of the stomach to the hernia, which protruded between the eighth and ninth ribs on his left side. Cause of death and postmortem findings were not obtained.

XI. Llobet, *Onze annes de pratique chirurgicale,* Paris, Balliere, 1898. Cit. after Neugebauer, *Arch f. klin. Chir.*, Bd. 73, p. 1014, 1904.

Soldier of 58, who 15 years before had received a stab wound in 8th left interspace between mammillary and anterior axillary lines. A swelling the size of a hen's egg developed at this point.

At operation a thoracoplastic flap was fashioned. The omentum and colon, found in the pleural cavity, were reduced, and the diaphragm was closed by suture. Operative recovery, but patient died six months later from an infection originating in a rib caries.

XII. P. Marzetti and S. Venanzi, *Il Policlinico, Roma,* 1906, xiii, p. 1554–1556.

A peasant of 70, when 21 years old, had received a stab wound in the ninth left interspace between the mammillary and anterior axillary lines. The wound, which was 2 cm. long, was sutured. The patient made a rapid recovery.

A hernia appeared which gradually increased to the size of an orange. It always was easily reducible.

February 21, 1905, patient came to operation with an ileus of two days' standing. Under cocaine anæsthesia the sac was opened and found to contain omentum and a gangrenous loop of gut. This was resected. The defects in diaphragm and chest wall were repaired. Recovery.

XIII. P. Postempski in the *Bull. d. r. Acad. Med. di. Roma,* 1888–89, xv, p. 191, reported the case of a boy with an epiplocele of the left eleventh inter-space following a wound there. An intercostal incision sufficed to give adequate exposure (it was not necessary to divide ribs); 10 cm. of omentum were resected, the omental stump was reduced into the peritoneal cavity. The wound of the diaphragm (2.5 cm. long) was sutured with fine silk. Layer sutures of the rest of the wound. No drainage. Recovery.

An interesting feature of this case was the occurrence of a left pneumothorax upon freeing the omentum. Except for a subcutaneous emphysema of the left thorax and left side of the neck, there were no untoward results from this.

Etiology.—A study of the cases collected shows that intercostal diaphragmatic hernia has followed wounds from sharp objects or severe contusions along the left free costal border, and has even come on after strains, such as lifting heavy weights or coughing. The ribs may or may not be fractured.

The hernia may make its appearance shortly after the trauma has occurred, or it may develop much later.

Site.—The region where these hernias have been observed to occur comprises the anterior parts of the sixth to the tenth left interspaces, inclusive. That is, from the median line to the left midaxillary line, just above the left costal margin. This is a strip which lies between the lower margin of the lung and the free border of the ribs. The trauma causing a hernia in this region usually causes adhesion of the phrenic and parietal pleuræ also, with consequent obliteration of the costophrenic sinus. In this zone, close to the lower margin of the thorax, the diaphragm and intercostal muscles lie close to each other in almost the same plane; hence, rupture of tissue at this point (in the costophrenic space and sinus) favors formation of an intercostal hernia. Higher up, wounds involving both intercostal spaces and diaphragm favor the establishment of pneumothorax and of a diaphragmatic hernia which does not tend to emerge between the ribs.

The presence of the liver on the right side usually prevents the formation of herniæ in a corresponding situation there.[3]

Anatomy.—The opening may barely admit the tip of a finger, or may be large enough to permit the introduction of the entire hand. It usually is bounded above and below by the sharp edges of adjacent ribs, and in front and behind by the cicatricial margins of the remaining intercostal muscles in that space. The size of the hernia may vary from that of a pea to that of an ostrich egg.

A rudimentary attempt at sac formation is usually found near the neck of the hernia. Like in other traumatic herniæ, the occurrence of a sac is uncommon, and adhesion of contents is the usual condition.

The contents may comprise omentum, transverse colon or splenic flexure, stomach, or small intestine. These will again be referred to in discussing diagnosis.

Symptomatology.—The subjective symptoms may be nil; or, again, there may be much suffering from pain and digestive troubles due to adhesions, as seen in the case reported by Cloquet, where the patient became so miserable that he was described as presenting a "cachexie herniaire." However, these troubles are common to adhesions of the stomach and the intestines from other causes, and are therefore of no further interest here.

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[3] A case which might possibly have been an intercostal diaphragmatic hernia of the right side is described on page 516 of the Medical and Surgical History of the Civil War, Surgical Volume, Part I.

The objective symptoms are those of other herniæ. There may or may not be a scar, depending on the etiology. Increase in size on inspiration, a differential point of value, may not be obtained except in certain positions. In most cases, reduction was easy; in a few it was impossible. Where gut is present and the hernia is reducible, reduction with a gurgle can be obtained at times. The consistence of the herniæ and likewise the findings on percussion depend upon their contents, whether omentum, gut, or stomach.

Over herniæ which contained part of the stomach, typical intermittent splashing sounds were heard when the patient drank. Peristaltic borborygmi could be obtained over a hernia containing gut.

The X-ray is of great service in the diagnosis, even without the aid of bismuth. Much accurate information regarding what parts of the digestive tube are present in the hernia can be obtained by making a series of Röntgenoscopic observations after administration of bismuth carbonate meals and enemata.

Diagnosis of the condition is readily established, except where the hernia consists of an incarcerated epiplocele. The fact that the tumor lies *lower* than the inferior limit of the lung is a most important point and one very apt to be disregarded. Reduction with a gurgle, increase in size on inspiration, and the presence of digestive disturbances are not invariable symptoms, but are of great diagnostic aid when present.

Differential diagnosis from such conditions as subcutaneous emphysema, hæmatoma, or pneumocele following a contusion, should not be difficult. Emphysema gives a characteristic crackle, and is usually diffuse; a hæmatoma does not change its size with respiratory movements; a pneumocele lies higher than the usual intercostal diaphragmatic hernia. Again, even if a pneumocele is of long standing, that part of the lung within the hernia usually remains unchanged,[4] and hence it should be possible to obtain diminution on inspiration, a normal percussion note, crepitation upon reduction, and normal breath sounds upon auscultation.

The differential diagnosis between an irreducible incarcerated omental hernia and an irreducible pneumocele with thickened or atelectatic lung tissue may not be easy. The location of the swelling and the presence or absence of digestive disturbances may serve as clues.

A subpleural lipoma projecting through an intercostal space has been observed.[5] Its occurrence is very rare. It is usually found in the upper thorax, but should such a tumor occur in the lower thorax, there might be considerable difficulty in diagnosis.

Prognosis depends upon the same factors as in herniæ in general.

Treatment.—Treatment consists in the application of a suitable bandage or truss, or in operation. A glance at the cases published shows that the operative procedure has not always been easy. As said before, there was usually no true sac, and where some sort of sac existed, there were many adhesions between its walls and the hernial contents. The best plan, therefore, is to dissect close to the neck of the hernia and gain an entrance into the free peritoneal cavity. After this, freeing and reduction of the contents can be done more easily and as circumstances dictate. It is well to bear in mind that the gut or pleural cavity may be accidentally opened, and therefore to be fully prepared for such contingencies. The closure of the opening may present certain difficulties. If it is not possible to make a layer suture of the diaphragm and intercostal muscles, owing to an inelastic ring of cicatricial tissue by which the diaphragm and thoracic wall are fused together, the ribs above and below may be approximated, obliterating the space through which the hernia formerly protruded; or, a plastic closure may be resorted to, using fascia, periosteum, or part of the latissimus dorsi.

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[4] Auler, Julius: "Beitrag zur Kenntniss der Lungen bruche." Berlin, 1892.

[5] C. Gussenbauer: Cit. after H. Tillmanns, Lehrbuch der speciellen Chirurgie, 3rd Ed., Part I, vol. ii, p. 605, Fig. 334

To sum up, intercostal diaphragmatic herniæ (1) are usually traumatic in origin; (2) they occur mostly on the left side in the anterior portion of the intercostal spaces (sixth to tenth inclusive), a region lying between the lower margin of the lung and the free border of the rib from the midline to the midaxillary line; (3) their symptoms are those common to herniæ in general; (4) the X-ray is of great value in determining the relationship of the various parts of the alimentary canal to the herniæ; (5) the details of operative treatment vary with the findings in individual cases.

It is the writer's opinion that the occurrence of these herniæ is not as rare as the few published communications on this subject would lead one to believe.

AN EXPERIMENTAL STUDY OF THE MANAGEMENT OF POST-OPERATIVE THORACIC INFECTIONS.*

A PRELIMINARY REPORT.

BY NATHAN W. GREEN, M.D.,

AND

HENRY H. JANEWAY, M.D.,

OF NEW YORK.

EMPYEMA of the pleura following some infectious process in the lung is not, as a rule, rapidly fatal. It is generally walled off by adhesions causing a closed abscess. This abscess can be drained and immediate danger of death averted. Purulent pleuritis following surgical trauma is different in its progress, and the event of death is proportional in frequency to the amount of shock accompanying the initial infection. Our own experience demonstrates to us the truth of this statement both from an experimental and clinical standpoint. Death may be caused by one of the following three factors, but usually is due to their combined action:

A. Physical—impairment of the respiratory mechanism, producing either complete or partial collapse of the lung.

B. Physiological—following fatigue of the respiratory apparatus, in part due to physical causes just mentioned.

C. Infectious—due to local and general bacterial invasion.

If we can overcome in the laboratory the combined effect of shock, coupled with one of these aforesaid three, we feel confident that these methods applied to the human being will give better results.

Let us compare the conditions found in the abdomen with those in the pleural cavity. We see here four points of difference. In the case of the pleural cavity, first, there is negative pressure; second, a rigid chest wall; third, a greater motility of the viscera; and fourth, there is the tendency to retract rather than to approximate and form adhesions. Sauerbruch and Robinson[1] have dwelt at considerable length upon the importance of this last factor.

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* Read before the New York Surgical Society, May 10, 1911.

If, now, we can by artificial means bring about conditions in the chest approximating those in the abdomen, we may hope for recovery after purulent infections, even as is now the rule in the abdomen.

Not one case of carcinoma of the cardia operated upon by the transthoracic route has been reported that has lived more than five days. The operation has been carefully done, the patient has rallied from the operation, but has died after forty-eight hours from undrained purulent pleuritis. This fact we may not lightly disregard. Drainage of some sort must be established in order that thoracic operations may be more successful. In previous papers[2] [3] we have stated that we believe herein lies the solution of this problem. It would be ideal to hope for intrapleural healing without infection and without adhesions of the pleura.

If, now, we look at a suppurative process within the abdomen, we see that one of the conservative steps of the process is the early formation of adhesions. Why not transfer this principle, then, by artificial means to the thorax? How shall we accomplish this? By approximating the visceral and costal layers of pleura and keeping them in apposition until adhesions shall have formed; thus preventing the existence of dead spaces in the pleural cavity.

In looking over the results of this last winter's work, we find that we have operated upon over 50 animals, all under general anæsthesia. We must view our results with an impartial judgment.

Among the procedures which we have attempted, we have tried a permanent drainage of the chest with a tube designed to be of such diameter that the inflow and outflow of air in the act of coughing was but of small amount, and so arranged that when the dog closed his glottis the lung could be inflated, blowing out fluid and air from the pleura. At the same time the aperture was not large enough to embarrass violently the respiratory act. We have tried, also, intermittent drainage with a permanent tube in place. We have tried permanent drainage with a permanent tube, as suggested by Bryant. We have not yet tried Robinson's[4] very ingenious device for drainage. We have tried intermittent drainage with a tube introduced at intervals, adding, at the same time, positive pressure by introducing the animal's head into the cabinet. We have added to this, also, suction on the introduced tube. We have tried two-way irrigation alone and two-way irrigation with positive pressure. We have also attempted to limit infection to the site of operation by the injection of Hiss's leucocytic extract. (This was partially successful and gave significant findings.)

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[1] F. Sauerbruch and Samuel Robinson: ANNALS OF SURGERY, vol. li, No. 3, March, 1910.

[2] H. H. Janeway and N. W. Green: Deutsche Zeitschrift für Chirurgie, Band 107, 1910.

[3] N. W. Green: Surgery, Gynæcology and Obstetrics, vol. ii, No. 5, pp. 512-538, May, 1906.

The animals die with pus in the chest, with collapsed lungs, often with a general infection, or with exhaustion from labored breathing. A number we have saved for a certain length of time.

Where and from what does the infection come? To a certain extent by direct contamination from the opened viscera. We have found, however, that the pleura, if not too long exposed, will stand a severe contamination and the animal will survive. We have opened the chest under differential pressure, and opened the œsophagus, spread around œsophageal contents in the pleural cavity, sutured the œsophagus and closed the chest, and the animals have easily recovered.

Does it come from exposure of the pleura to the air? It does to a certain extent. We have opened the chest under differential pressure, and, without any further procedure, have left it open for two hours, then closing it we have found the dog infected, and the infection ran to a fatal issue.

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[4] Samuel Robinson: Boston Medical and Surgical Journal, vol. clxiii, No. 15, pp. 561-570, Oct. 13, 1910.

Is it due to a lowering of the animal's general and local resistance? In a recent article in the *Journal of Infectious Diseases,* Graham [5] states that ether diminishes the phagocytic action of the leucocytes. We have on this account conducted some of our experiments under nitrous oxide and oxygen. We have tried to make our work as rapid as possible, we have padded off the thoracic cavity, we have used sterile almond oil on the tissues to prevent drying, and yet in many cases shock combined with the infection has brought about a fatal issue.

At autopsy we have found quite a uniform picture: pus or seropurulent fluid, complete collapse of the lung upon the operated side with partial collapse upon the other side, adhesions where the lung touched the diaphragm and the site of the operation in the œsophagus, but only few adhesions between the lung and the chest wall. In a few cases examined we have obtained bacterial cultures from the liver.

In cases autopsied more than twelve hours after death there were apparent stitch leaks. In each of three cases autopsied immediately after death, the anastomosis was perfect, as tested by water pressure.

It seems, then, that it is not continued contamination but the result of contamination plus the presence of an area in which the resistance has been lowered, that induces the purulent exudate.

In the case of the animal, we have three things to contend with that do not obtain in the adult human subject. The first is lack of post-operative intelligence; the second, lack of a stable mediastinum; the third, lack of proper cleanliness. If we can overcome these, we stand a greater chance of making our experimental work more successful, and we can transfer our methods to the human species with added confidence.

To overcome these three things in the laboratory, it will be necessary to keep the animal, by some means, quiet for from twenty-four to thirty-six hours, to establish some permanent pressure within the lungs, and to prevent any inward suction of contamination from the wound-surface. It is suggested to establish a permanent differential pressure with the head in either a cabinet or a chamber such as that of Dr. Meyer, or with the thorax in a negative chamber such as the Sauerbruch cabinet. To facilitate getting rid of the purulent exudate, we suggest double current irrigation at the site of anastomosis while pressure is maintained, and we think it advisable to consider all operations upon the œsophagus occupying more than an hour and a half as being infected. We advocate, therefore, drainage to the site of the anastomosis for the first twenty-four to thirty-six hours.

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[5] Evarts A. Graham: The Jour. of Infectious Dis., vol. viii, No. 66, p. 152, Mar. 6, 1911.

Briefly, a plan which we have as yet been unable to adopt, but which suggests itself from our findings, is this: after the completion of the operation, a drain should be inserted to the bottom of the chest and site of anastomosis, which should be left in place for twenty-four to forty-eight hours. The animal should be given suitable medication to keep him quiet and, at the same time, free from distress. The head should be placed in a cabinet for a sufficient time to allow adhesions to form between the visceral and parietal pleura, and at the end of twenty-four hours a two-way irrigation should be performed down to the site of the anastomosis. After this the pressure may or may not be kept up for twelve hours longer, and on the following day the drainage should be removed.

THE SURGICAL CLINIC OF THE PROTESTANT EPISCOPAL HOSPITAL OF PHILADELPHIA.*

REVIEW OF 150 CONSECUTIVE OPERATIONS.

BY CHARLES HARRISON FRAZIER, M.D.,

OF PHILADELPHIA.

The series of cases herein discussed represent the surgical experience at the Episcopal Hospital in a three months' service, excluding a not inconsiderable number operated upon by one of the assistant surgeons or internes.

Morbidity.—Of the 150 operations of our series almost 100 were for lesions of the abdominal organs. Of the total number there were four deaths, a mortality of about 2.5 per cent. Two of these four deaths, as will be seen, may properly be excluded, so that the mortality may be reckoned as 1.3 per cent. The series include 30 operations for appendicitis and its complications, 22 for hernia, 8 for lesions of the stomach or duodenum, 18 for operations on the pelvic organs with 4 hysterectomies, 4 operations on the biliary passages, 14 upon the urinary organs, and 3 thyroidectomies.

Of the four fatal cases one was a case of tuberculous meningitis, which because of certain focal phenomena was regarded before operation as a brain abscess. An exploratory craniotomy seemed justifiable. The patient survived the operation but a short time, and the autopsy revealed the true nature of the lesion. The second was a strangulated umbilical hernia in an aged patient almost moribund, who scarcely survived the initial incision. These two might be regarded as inoperable.

The third death followed a suprapubic prostatectomy and bilateral herniorrhaphy under spinal anæsthesia in a patient 75 years of age. The patient's condition at the end of the operation was excellent and continued so beyond the period at which post-operative shock would have developed. But his vital processes gradually failed, and he died three and a half days after the operation. The fourth of the fatal series was in a patient who had been operated upon for gall stones. This case presented some interesting features and will be alluded to later.

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* Read before the Philadelphia Academy of Surgery, May 1, 1911.

Technic.—In the preparation of the field of operation the Grossitch or iodine method was used, preceded by a single preparation with soap, alcohol, and bichloride. The addition of iodine to the technic has so diminished instances of accidental infection that I am disposed to omit altogether any attempt at chemical disinfection with alcohol and bichloride. There was but one frank suppuration in our wounds, and in that instance there were a few small pustules at the site of the wound before the operation to which the infection may be attributed.

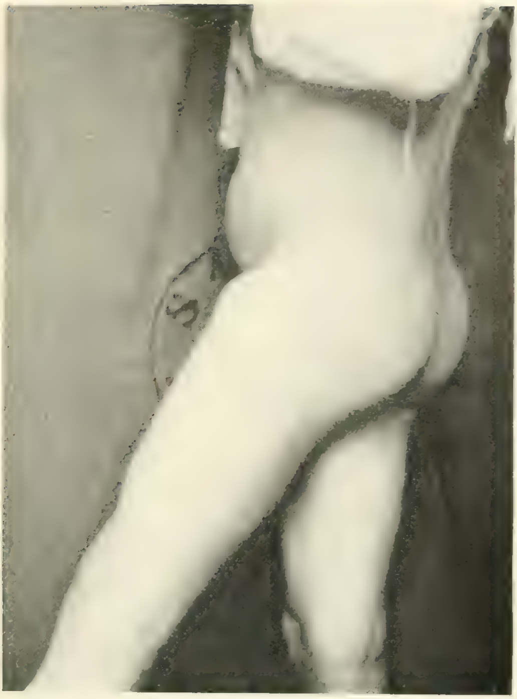
In the post-operative period, after operations with incipient or advanced peritonitis, after operations in the upper abdomen, and in all cases of advanced years with few exceptions, the patients were put in the sitting posture for at least 48 hours. This I believe minimizes the incidence of pulmonary congestion and in many instances adds materially to the comfort of the patient.

Proctoclysis was employed wherever for any reason the administration of water or liquids of any character by mouth was prohibited.

Anæsthesia.—The selection of an anæsthetic deserves much more attention than it receives at the hands of most surgeons. No matter how skilled the anæsthetizer may be in the administration of ether, there are certain cases where for the comfort and safety of the patient either spinal or nitrous oxide anæsthesia should be employed. While I do not believe nitrous oxide anæsthesia will ever come to be universally used as a substitute for ether, there are many occasions where it is an important factor in the saving of life. In cases of severe toxæmia, where patients are profoundly septic, as in some cases of gangrenous appendicitis, of peritonitis or gangrenous cholecystitis, in empyemata while resecting the rib, in suprapubic cystotomy for drainage or stone, in kidney decapsulation or nephrectomies in septic cases, or in strangulated hernias; in all these, as in many other minor procedures, there can be no question as to the value of nitrous oxide anæsthesia. Its safety in competent hands is unquestioned; it relieves the patient of the ether discomforts, but above all it minimizes the risk of operation where life is hanging in the balance and the depressing effects of ether would be enough to turn the scale. Where abdominal relaxation is necessary, ether is substituted for a few moments until relaxation is obtained, returning to nitrous oxide.

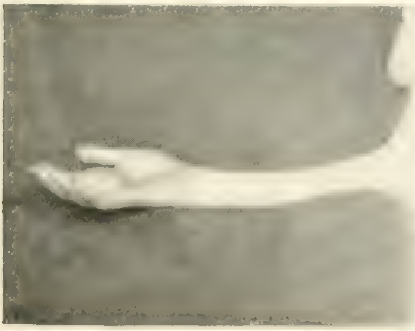
Spinal anæsthesia, too, has its special indications, it seems to me, particularly in patients with pulmonary tuberculosis and in elderly people, where, because of valvular lesions or myocarditis, the administration of nitrous oxide may be not unattended with risk. In this series I used spinal anæsthesia in the following operations: a colostomy for inoperable carcinoma of the rectum; suprapubic drainage of a large abscess of the pelvic region in a septic patient; in a laparotomy for tubercular peritonitis and another for cirrhosis of the liver; in a suprapubic cystotomy; in a suprapubic prostatectomy; in the repair of a vesicorectal fistula. Scopolamine gr. 1/150 two hours before and morphine sulphate, gr. 1/6 one half hour before the operation so benumbs the sensibility of the patient, that, though conscious during the operation, he suffers from none of the ill effects which might come from fright in a wide-awake patient. From spinal and nitrous oxide anæsthesia there were no ill effects. The only serious complication occurred in an operation for hydrocele. The patient was an alcoholic; after a considerable quantity of ether had been administered without avail, chloroform was substituted, and just as the incision was made the heart stopped beating. Cardiac massage was resorted to by the transdiaphragmatic method, and in the course of a few moments feeble fibrillary contractions could be felt. Gradually the cardiac contractions became more perceptible and regular, and after ten minutes resuscitation was established. The abdominal wound was

FIG. 1



Photograph showing a fibrolipoma of the sartorius muscle mistaken before operation for a hernia. Note protrusion on the anterior surface of the upper portion of thigh.

FIG. 2



Photograph of a congenital [illegible] the hand with [illegible]

[illegible]

Application [illegible]

FIG. 4

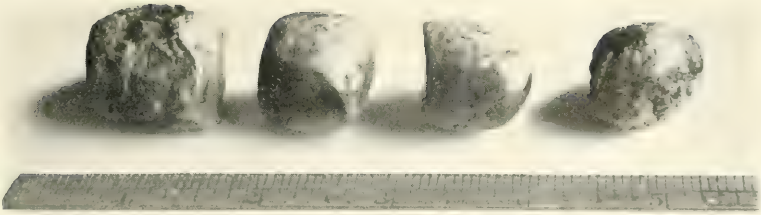
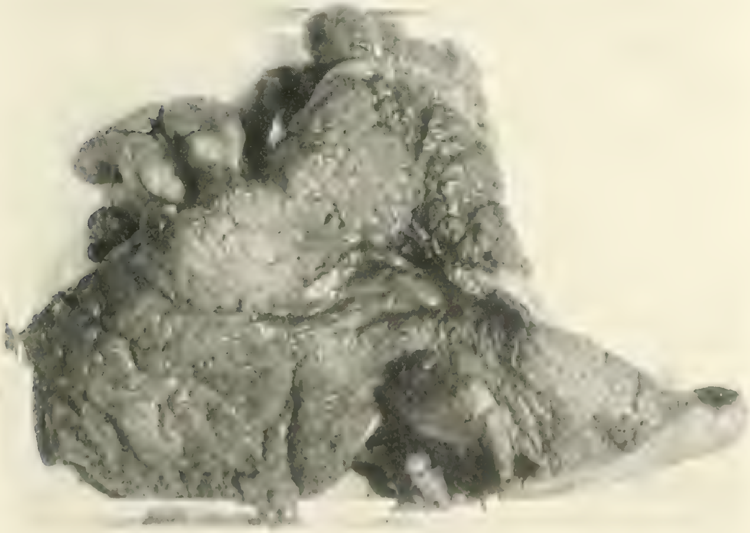


Illustration showing series of gall-stones arranged in column as they were found imbedded in a mass of inflammatory tissue after having escaped from the gall-bladder of a patient who had been free from symptoms until within two months of the date of the operation.

FIG. 5.



Portion of stomach removed, showing in centre of specimen the crater of the perforating ulcer on the lesser curvature.

closed, and the operation on the hydrocele completed. The patient suffered no relapse, and the subsequent course of events was uneventful.

Tumors.—Curiously enough the district upon which the hospital draws for its material is not a fertile one for tumors. Relatively speaking there are few operations for cancer, exclusive of the uterus, and I have often attributed the paucity of malignant cases in the clinic to the popular impression among the less enlightened classes, that cancer is a disease of the blood and removed by operation always returns in some other place. Of the benign tumors there were three unusual enough to deserve mention. One was a lipoma in the belly of the sartorius muscle, about eight inches below Poupart's ligament (Fig. 1). The tumor protruded above the surface only when the patient contracted the muscle. On first examination the character of the lesion was not suspected; it was thought to be a muscle hernia. The second was a tumor of the breast, which, because of the associated enlargement of the axillary lymph-nodes, was thought to be either carcinoma or chronic cystic mastitis; but upon histological examination proved to be a fibroma. In the third case there was a large congenital angioma involving the palmar surface of the hand (Fig. 2) with digital extensions.

Appendectomies.—In the management of the appendix cases no hard or fast rules were laid down. It was not our practice to attempt to classify our cases as early or late to gratify the statistician, according to whether they were operated upon in the first 48 or 72 hours or later. In the acute cases with few exceptions the operations were performed as soon as the diagnosis was made. To this general rule there were certain exceptions. When the patient was first seen at the end or near the end of a mild attack we consulted our convenience as to the time of operation. Furthermore we advocated the starvation plan in a few cases of the following type: usually some time has elapsed since the onset of the attack; it may be only two days, more likely, however, three to five; the patient looks toxic, he is toxic; his pulse is rapid, over 120; the abdomen is distended and more or less tender everywhere; peristalsis has been altogether or partially arrested, perhaps reversed with vomiting; restlessness and anxiety are written on the patient's face. In other words the infection is a wide-spread one. Sometimes this picture develops earlier, sometimes later, but whenever it comes I am convinced that the best results will be obtained by conservative practice, *i. e.*, by privation as to solids or liquids by mouth, proctoclysis, and posture.

One often hears or reads of bitter disputes as to whether the time limit between the early and late cases should be placed at 48 hours or later. Such discussions are futile, for early or late are but relative terms when applied to a given case. Each case must be a law unto itself, and no rules can be laid down comprehensive enough to allow for the innumerable variations.

It has been said, and very properly, that appendicitis is a surgical disease; no one denies it. The surgeon reserves as his privilege the right to decide upon the operability of a given case; that privilege is usually accorded him. In the exercise of this privilege he selects some cases for the Ochsner treatment and some of those cases may—before being operated upon—die. In the publication of his mortality statistics the surgeon usually excludes these. I believe, however, the time has come when the only means of determining the morbidity of appendicitis is to include in our death-rate those treated by both conservative and operative measures. We used to throw the responsibility on the medical men for all unoperated cases. But we cannot consistently do this any longer, if we take the stand, as I believe we should, that appendicitis is a surgical affection first, last, and always, and reserve the right ourselves to set aside a certain group, as I also believe we should, for conservative treatment. Having assumed entire responsibility for all cases, we must include in our statistics the fatal results in the unoperated as well as operated cases.

Irrespective of the appendices removed incidentally at other operations, there were 30 removed which were found at operation or in the laboratory to be diseased. There were no fatalities in this series, but *apropos* of what has just been said of the mortality statistics I should refer to the case of a young man, who when first seen on the fifth day of the disease, was desperately sick. I declined to operate, and watched him carefully from day to day. Under the treatment prescribed his improvement with each 12 hours was marked, until four days later the distention had subsided to a marked degree, his tenderness had become circumscribed to the right iliac fossa, the pulse fell to 70, and the clinical picture was transformed from one of general to one of local peritonitis. I had planned to operate on the following day, but in the course of the early morning hours, the patient without warning developed signs of collapse from which he did not rally. No autopsy was performed and the cause of death was a mystery. At the same time it should occupy just as conspicuous a place in my statistics as a death following operation.

The technic of the operation calls for little if any comment save with reference to the matter of drainage. In this I find myself using drainage in an increasingly smaller number of cases, and when drainage is required using less drainage material, rarely anything but split rubber tubing with a wick of gauze. The fundamental principle in draining the peritoneal cavity is the relief of pressure afforded by the opening in the abdominal wall. This need not be larger than to accommodate one or two full sized drainage tubes. I no longer have a wound entirely open and filled with gauze, and I close wounds without drainage sometimes even when there is a small accumulation around the appendix, thoroughly disinfecting the region with alcohol.

Hernia.—Of the hernia series there were 22 cases, of which 13 were indirect and 3 direct inguinal, 2 recurrent, 1 femoral, 2 ventral, and 1 umbilical. There were no unusual types except an irreducible omental hernia in a young adult, a case in which the diagnosis was not established until the operation. Without impulse it presented the earmarks of a lipoma. Of the series there was one fatal case in a large strangulated umbilical hernia of four or five days' duration, in the person of an aged woman who was generously referred to my service by a practising surgeon of a neighboring hospital. The patient was almost moribund at the time, and did not more than survive the hasty attempt to expose and free the contents of the sac.

The method of procedure in the inguinal type varied according to the character of the hernia; in some instances the simple Ferguson, in some the Bassini, and in others the imbricating method of Andrews was used. In the selection of the method I have always tried to observe the general principle of disturbing in the least degree the normal anatomical relations. Thus in the hernias of children and the incipient hernias of young adults where the rings are not large and the musculature all that could be desired it is not necessary to transplant the cord. After isolating the sac and freeing the neck from its attachments and ligating it an inch beyond the margins of the internal ring, the internal oblique and conjoined tendon were sutured to Poupart's ligament without transplanting the cord; and the wound in the external oblique sutured without imbrication. In complete hernias of longer duration with larger rings the Bassini method was adopted. The remaining group included hernias of still longer duration, where the rings are more or less approximated, all direct hernias, all hernias in elderly people with musculature flabby and without tone, and hernias in which the conjoined tendon is altogether obliterated. Here I invariably resorted to the imbricating method of Andrews, in some cases splitting the sheath of the rectus and using either the belly of the muscle or flap of the sheath to fortify the defective area at the lower portion of the canal. This operation in this particular group is vastly superior to the Bassini method and should always be given preference. In all the operations, the incision in the external oblique is made a little above, instead of directly over, the canal and carried down as Judd recommends above and to the inner side of the internal pillar of the external ring so as to leave this structure intact. In introducing the deep mattress sutures in the reconstructive stage, my practice differs somewhat from the conventional procedure, in that I introduce the needle from the external aspect of the shelving edge of Poupart's ligament, and the knot is tied in the outer rather than the inner aspect (Fig. 3). This is a matter of but minor consideration, but has been adopted because it avoids the splitting or tearing of the edge of Poupart's ligaments, which sometimes happens when traction in the suture is made to approximate the edges. For this suture I prefer to use a double strand of No. 0 or No. 1 catgut to a heavier single strand, as I always feel a little more confident of the sterility of the finer material.

We are gradually being weaned from the tradition that gall-stones are innocuous in many instances throughout life to be discovered only at autopsy. That many cases of cholethiasis have been treated for many years for stomach trouble we know too well, but in exceptional instances one runs across a patient in whose history there is nothing either indicative or even suggestive of the existence of gall-stones.

Such was the case in K. S., aged fifty, who told me she had never been sick in bed, that she had never been treated for dyspepsia, and had none of the digestive disturbances so common in cholelithiasis much less any of the acute exacerbations of biliary colic or subacute cholecystitis, at least until two months before the operation, when she had attacks of pain in the upper abdomen which had confined her to bed for a while. I questioned her myself with great care, as the physical signs pointed to the biliary passages. There was a mass in the abdomen about the size of a fetal head, extending from the margin of the ribs to the umbilicus. It did not move freely with respiration, and was not continuous with the margin of the liver. Through a right rectus incision I came down at once upon a mass, surrounded by adhesions, which were separated with great difficulty. Finally a cavity was opened containing pus and four large gall-stones (see Fig. 4). These were firmly imbedded in the inflammatory mass, arranged in single column, and faceted at either end where they were in direct contact. There was no escape of bile at any time, and nothing which could be identified as a gall-bladder was seen. The gall-stones, which must have been there months if not years, had ulcerated through the gall-bladder and became imbedded in a mass of inflammatory tissue. For two days the patient's condition was most satisfactory, but on the third day there was for the first time a copious discharge from the wound, which was believed to be bile. On the fourth day 90 ounces of this fluid were collected.

Her pulse was growing more rapid and weaker, her skin leaky. I was at a loss to account for her rapidly failing strength. I began to suspect the fluid draining in such quantities was not pure bile; specimen examined disclosed hydrochloric acid, and further investigation pointed to a fistulous communication with stomach and duodenum, probably resulting from the trauma incidental to the liberation of the gall-stones from the inflammatory bed. The patient was taken to the operating room again, and through a left rectus incision our suspicions were confirmed. The tissues about the perforation were so fragile that it could not be satisfactorily closed with sutures. Accordingly a gastrojejunostomy was performed and the pyloric outlet closed. The patient did not react and died the following day. Had the true nature of this lesion been recognized sooner, I cannot but feel she would have survived the second operation.

Of the lesions of the upper digestive tract there were in all nine cases, two gastric carcinomas, two gastroptoses, three gastric and two duodenal ulcers. All were operated upon and there were no fatalities. It is interesting to note that in the ulcer cases the proportion of males to females was four to one, a further evidence of the greater prevalence of ulcer in the male sex.

Before discussing the operative procedures in this series I will refer to some interesting facts bearing upon the diagnosis and symptomatology.

In one case, B. F., an engineer, fifty-five years of age, the pre-operative diagnosis was cholelithiasis. There was a history of stomach trouble covering a period of two years, with bilious attacks and occasional vomiting; the patient stated that he had been jaundiced off and on, that his stools had been clay colored, and that discomfort followed eating. There was some rigidity and tenderness over the gall-bladder, and the scleræ were jaundiced. At the operation a typical saddle-back ulcer was discovered, with an unusually extensive infiltration of the gastrohepatic omentum. To the encroachment of this upon the common duct we attributed the signs of obstructive jaundice which led us astray in the diagnosis. The ulcer-bearing area with a portion of the gastrohepatic omentum was resected, and all the symptoms, including those of common duct obstruction, disappeared (see Fig. 5).

The unreliability of the gastric analysis in the diagnosis of gastric or duodenal ulcer or cancer was forcibly illustrated in our cases. As to the presence of hyperacidity or of occult blood in the contents of the stomach or bowel, I am becoming more and more convinced that to wait for such laboratory indications of ulcer is unjustifiable in the presence of a reasonably clear history. It is after all the history upon which we must place the most reliance, and upon which our decision for or against operation must be founded. Unfortunately the "history," so called, is often not an accurate record of the development of the disease in chronologic order, but a collection of isolated facts forced from the patient by a system of cross-examination at the hands of one who often approaches the case with preconceived notions as to the diagnosis and conducts his examination accordingly. A better term, as some one has recently pointed out, is anamnesis, which implies a record of the disease from the patient's recollection, and if the patient is intelligent enough it should be written by the patient and not for him. That one may sometimes be misled, however, by the history is shown in my experience with a young woman evidently neurasthenic in temperament. Although skeptical about the existence of a gross lesion, I was finally persuaded to explore the upper abdomen, because of the very positive evidence of hæmatemesis and of aggravated attacks of vomiting and pain. The findings at the operation were negative and I ascertained afterwards from the patient that she was in the habit of sucking the gums till they bled, swallowing the blood, and then inducing vomiting. Hence the hæmatemesis.

To me an interesting case, because of the difficulty in diagnosis and the duration of the disease, was of a young man then thirty-one years of age, who had been ailing twenty years off and on; at the age of eleven he had an attack of vomiting with abdominal pain which confined him to bed for ten days; and even prior to that time had what he called indigestion. He had served in the army during the Spanish War, and since then had worked steadily as a machinist. His work had never been interrupted, he ate everything, had never vomited, and never had any blood in stools. His chief and only complaint was pain, worse when the stomach was empty, often having to get up at night for a glass of hot milk or water. There was no occult blood, no hyperacidity, no dilatation of stomach. He was tender over his epigastrium but he was tender also over his appendix. Although the clinical picture did not conform altogether to type, I thought we were dealing with a case of appendicular dyspepsia, a chronic appendix with gastric symptoms, and proceeded accordingly. Through a gridiron incision I explored the appendix, and found it buried in a mass of adhesions, and liberated it with much difficulty. Though there was no doubt as to the existence of a lesion of the appendix, I was still in doubt about the upper abdomen, which I explored through a right rectus incision and found the stomach and omentum plastered to the parietal peritoneum, and on further investigation an ulcer of the lesser curvature. From the extent of the peritoneal invasion there had evidently been at one time some leakage. The operation concluded with a gastrojejunal anastomosis. Recovery was uneventful.

The method of procedure in gastric ulcer necessarily varies. However, I strongly advocate excision of the ulcer when this is feasible, and especially in the large indurative type, including the saddle-back ulcer in patients approaching middle life. It is in this type that carcinoma is most frequently implanted, and for this reason alone, if for no other, we owe it to our patients to practise the more radical procedure. These ulcers should be looked upon as precancerous conditions and treated accordingly. When the ulcer is so situated or so adherent to adjunct structures as to make excision difficult, the pyloric outlet of the stomach should be closed by infolding as the surest safeguard against recurrence and as the most rational way (in the light of our present knowledge of the pathogenesis of ulcer) of securing permanent results. The same practice is indicated, I believe, in duodenal ulcer as well, although in my experience the tendency to recurrence in the latter is not as great as in gastric ulcer. The operations in this series of gastric cases were carried out according to these principles. In technic the no-loop gastro-jejunostomy, vertical opening was used, the line of sutures protected as Mr. Moynihan suggests with the gastrocolic omentum.

The management of actively bleeding ulcers requires the exercise of one's discretion. Ordinarily I favor palliative procedures.

For example one of our patients, a young woman of twenty-two, with a five-year ulcer history, had three large hemorrhages in five days, once vomiting three quarts and with a large quantity of blood in the stools. On admission she looked exsanguinated, her hæmoglobin was low. I decided not to operate at once, ordered 20 cc. of horse serum given hypodermatically, morphine q.s. to allay pain and restlessness, and small quantities of saline solution by bowel, and an ice bag to the abdomen. After five days of freedom from hemorrhage or vomiting I operated and found an ulcer on the greater curvature. If, on the other hand, the plan of treatment had been of no avail and hemorrhages recurred, with increasing frequency or in increasing amounts, there would then have been but one recourse, immediate operation.

Of the pelvic cases, in fact of the entire series, the most puzzling was in the person of a patient fifty years of age referred to me by Dr. E. F. Walsh. She told me that she had not been well since the birth of her last child three years ago, and prior to that had had one miscarriage, that her menstruation had been regular until the last period now two weeks overdue. She laid emphasis on troublesome attacks of indigestion with vomiting, for which her physician had treated her from time to time. Eight days prior to admission, after a hearty meal, she was seized with a violent pain and vomited. For the next three days vomiting continued but the pain was less severe. She remained in bed with a normal temperature on a liquid diet and on the day before admission she had had another attack of severe pain similar to the first. When I saw her she appeared exsanguinated, her hæmoglobin was 20 per cent., the leucocytes 22,400, and pulse 140; the abdomen was distended, and she referred her pain to the epigastrium and precordium. My first thought in view of the history of digestive disturbance, the intense pain, and attacks of vomiting was hemorrhage from a duodenal ulcer. In her present condition operation seemed out of the question, so I watched her carefully day by day and gradually the symptoms of the upper abdomen disappeared and were replaced by an area of dulness and tenderness in the lower abdomen. To make a long story short, when her condition justified it I opened the abdomen and found we were dealing with an ectopic gestation. From a pint to a quart of partially organized blood-clot was removed together with the sac. There was no post-operative shock, and convalescence was rapid and uneventful.

Unfortunately the Episcopal Hospital is so far removed from the center of the city as to be inaccessible both for the casual visitor and student alike. This isolation is a great drawback, as there is nothing so stimulating to the whole staff of a hospital, from the highest to the lowest officer, as the constant criticism and searching inquiry of those who are seeking useful information in modern methods of procedure. Because of its isolation the physical equipment of the hospital is known to few of the profession, resident and non-resident. Perhaps the most favorably situated of the larger hospitals for service to the working classes, it has a wealth of material representing the whole field of surgery. Of the lesions of the extremities, there is an extraordinary opportunity to study fractures of every description, and of the abdominal lesions there is a veritable mine of examples of inflammatory conditions of the pelvis, most of which are the result of improper care at childbirth at the hands of incompetent midwives or the patients themselves. To the philanthropically inclined I know of no better object for investment than the establishment of a maternity department for the poor of that district.

The service of this hospital, as of many others, is an interrupted one. The disadvantage of this system pertaining in many institutions is well recognized and so patent as to admit of no dispute. Far better is the European system, where in each hospital a limited number of surgeons devote their entire time to the instruction of young physicians and surgeons and the utilization of the material at their command for the advancement of medicine as a science and an art.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY.

Stated Meeting, held May 10, 1911.

The President, Dr. Ellsworth Eliot, Jr., in the Chair.

ŒSOPHAGOSCOPIC AND GASTROSCOPIC EXAMINATIONS.

Dr. Henry H. Janeway (by invitation) and Dr. Nathan W. Green demonstrated the use of the gastroscope, and made some observations upon its surgical use and value.

Dr. Henry H. M. Lyle said that in hospitals it had been no easy matter to induce patients to submit to gastroscopic examinations, but, as a matter of fact, his own observation and experience had shown him that the procedure was not at all difficult. The larger tube of Mikulicz was somewhat harder to pass than Chevalier Jackson's; on the other hand, the Mikulicz tube was superior to that of Jackson for the purpose of removing sections, as it gave a better view in some respects.

Dr. Janeway, in reply to a question, said he had never seen severe bleeding after the removal of sections from the cardia or œsophagus. After removing the section and mopping with a bit of cotton, the hemorrhage, as a rule, was not severe enough to interfere with the view.

In connection with this paper, Dr. Janeway said he wished to make it clear that it was merely a preliminary report, but that it indicated a successful solution to a problem which ought to be solved.

The confirmation of the diagnosis by the removal of bits of tissue in so large a proportion of the cases of carcinoma of the stomach was presented with some hesitation, inasmuch as the series of cases was as yet too small to enable one to judge whether subsequent experience would be so successful.

AN EXPERIMENTAL STUDY OF THE MANAGEMENT OF POST-OPERATIVE THORACIC INFECTIONS—A PRELIMINARY REPORT.

DR. NATHAN W. GREEN and DR. HENRY H. JANEWAY read a paper with the above title, for which see page 549.

DR. WILLY MEYER said there could be no doubt of the fact that, since the introduction of the differential pressure apparatus the thorax could be simply and safely opened. In a number of instances he had been struck by the fact that the patients stood the operation very well, but that on the second day signs of dyspnœa and cyanosis appeared, sometimes with fatal results. In one of the earlier cases operated on at the German Hospital, where both pleural cavities were opened, and the thoracic incision closed air tight, the patient did very well for sixteen or eighteen hours after the operation; he then beame profoundly cyanotic, and before he could be brought back under the influence of the differential pressure, where the wound could have been reopened, if necessary, he passed away. In that case there was a carcinoma of the œsophagus, and a resection of the latter had been done. The patient was a man, sixty-four years old, and the operation was quite a severe one. At the post-mortem examination, both pleural cavities were found filled with a large amount of serosanguinolent fluid, and the lungs were compressed and collapsed.

This and subsequent cases, Dr. Meyer said, had convinced him that besides doing the actual work under differential pressure, we had to learn to drain these wounds. In the new pavilion for thoracic surgery at the German Hospital, arrangements had been made for two recovery rooms, which were located adjacent to the differential pressure apparatus, and here patients who had been operated on under differential pressure were kept for twenty-four or forty-eight hours after the operation on special beds which were of the same height as the operating table and unobstructed at the head-end, so that if necessary the head of the patient could be readily placed in the differential air chamber. The pressure of the airlock gave free access to the patient's head for purposes of feeding, etc., by the relays of assistants and nurses.

Dr. Meyer said he appreciated the fact that the differential pressure method, as carried out at the German Hospital, was only one way of permitting surgeons to enter the thoracic cavity safely.

Other methods were known and other solutions of this problem would probably come to light. But whether or not intrathoracic work would have a successful issue would depend not only on the surgical technic itself, but on the proper after-management of the patient, especially on drainage of the thoracic cavity.

Dr. Green said that in the course of their experiments on animals, Dr. Janeway and he had noticed the same phenomenon mentioned by Dr. Meyer, namely, that in some instances after an intrathoracic operation the animal would progress favorably for sixteen, twenty-four or thirty-six hours, and would then begin to suffer from increasing dyspnœa and rise of temperature, followed by death. At the autopsy they found the lungs collapsed and the pleural cavities filled with a serosanguineous fluid. The speaker said he thought the collection of this fluid was undoubtedly due to the exposure of the pleura to the atmosphere for too long a time.

Dr. Green said he thought that Dr. Meyer's idea of immediately returning these patients into the differential pressure chamber upon the onset of these unfavorable symptoms was an excellent one. This would keep the lungs expanded, so that they would approximate the chest wall until adhesions should have formed; the track of the operation might then be easily drained.

REMOTE RESULTS OF RESECTION OF THE AORTA AND TRANSPLANTATION OF VESSELS.

Dr. Alex. Carrel read a paper with this title.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY.

Stated Meeting, held May 1, 1911.

The Vice-President, DR. JOHN H. GIBBON, in the Chair.

RESULTS AFTER REMOVAL OF AN EPITHELIOMA OF THE MANDIBLE, INVOLVING THE FLOOR OF THE MOUTH, THE CONTIGUOUS SURFACE OF THE TONGUE, AND THE GLANDS IN THE DIGASTRIC TRIANGLE WITH LIGATION OF THE EXTERNAL CAROTID.

DR. ADDINELL HEWSON presented a man, aged fifty-four years, who, when first seen February, 1909, presented a growth extending from the median line, on the left side, surrounding the roots of the central left lateral incisor and first bicuspid teeth, and extending into the floor of the mouth. It was of almond shape, ulcerated, and in the last six months had bled slightly. Enlargements in the digastric triangle were distinctly palpable. The growth had been very slow, but in the last two weeks had been rapid. The urinary examination was negative, and the blood examination showed no marked leucocytosis. The hæmoglobin was 87 per cent. Slight increase in the lymphocytes and decrease in the polymorphonuclear neutrophiles. The left external carotid artery was ligated as a preliminary to the operation. The incision for the removal of the growth was made in the median line and carried along the caudal margin of the mandible as far as the facial growth. A stout ligature was passed through the tongue, and a Gigli saw introduced, severing the mandible at the right canine tooth. The saw was again introduced, severing the mandible ventrad to the left facial growth, thus permitting the tongue floor of the mouth to be in the grasp of the part removed. The incision was now completed, removing a portion of the growth on the under surface of the tongue, the mylohyoid muscle, the attachments of the glossal and suprahyoid muscles, and the contents of the digastric triangle without involving the incision for the ligation of the left external carotid artery. The glossal muscles and the suprahyoid muscles were fastened to the remainder of the mandible on the right side, the margins of the tongue to the remains of the caudal fornix of the vestibule of the mouth, the wound closed with interrupted sutures, and a wick introduced in the bottom of each wound. The wound healed with slight stitch abscess, but there was no involvement of the carotid incision. The pathological report of the growth showed the presence of infiltration in the pearly bodies, also some infiltration into the tissue in the floor of the mouth and into the mucous and salivary glands. Some epithelial cells were found in the lymph-glands, and in some there was no infiltration whatever. The patient had an uneventful recovery, and was able to leave the hospital April 1. There was a slight recurrence in the alveolar process about the canine tooth, which was removed in May, 1910. Microscopically, this growth proved to be a slight recurrence. There was, at this time, no enlargement anywhere; patient's health was good, although absolutely adentulous, and compelled to eat soft food. In December, 1910, he reported, complaining of a small tumor about the size of a chestnut in the right supraclavicular region, which was very painful on manipulation. However, no manifestation of any connection with the mouth, and the swelling was treated as a result of cold and soon disappeared. This proved to be a fact, as, when the patient next appeared this growth had disappeared. At this date, May 1, 1911, there has been absolutely no return anywhere. The contraction of the muscles had produced rather a pointed chin, and the interval between the severed portions of the mandible was just the breadth of a finger. The tongue can be protruded to its normal length from the mouth, and the voice sounds give the impression of the patient lisping with a quid of tobacco in the mouth.

THE TREATMENT OF LACERATED AND INCISED WOUNDS OF THE EXTREMITIES, WITH REPORT OF FIVE TYPICAL CASES.

Dr. James A. Kelly read a paper with this title.

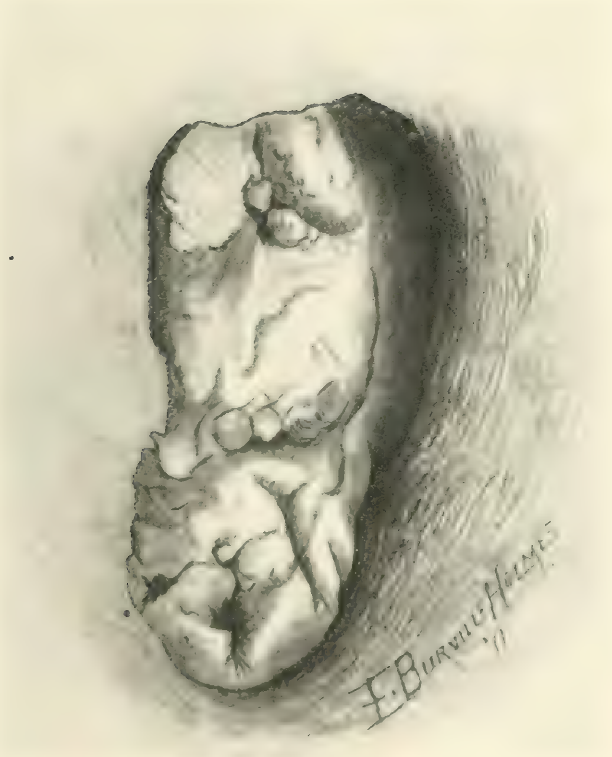
ANÆSTHESIA BY THE INTRATRACHEAL INSUFFLATION OF AIR AND ETHER.

Dr. Charles Elsberg, of New York, by invitation, read a paper with this title.

Dr. W. W. Keen said that eighteen months ago he had the pleasure of seeing Dr. Carrel at the Rockefeller Institute do a remarkable series of operations upon animals, using this method, with a very simple apparatus. The etherizer used the foot bellows, and there were two tubes, one going directly into the respiratory tube while by the other the air passed through a bottle of ether, with a clamp on each. Thus pure air or air with ether vapor could be used in any proportion. It was startling to see Carrel with one sweep of a large knife open widely both thoracic cavities, exploring lungs, heart, and pericardium without the slightest trouble. There was no disturbance of the circulation nor any change in the color of the animal so far as one could judge. Carrel was able then to handle the lungs and displace them and the heart freely. He then severed and anastomosed the aorta, first clamping the aorta above and below the point where he did the anastomosis. He had intended originally to introduce a piece of vena cava that had been in cold storage for a number of days, but the specimen proved not to be a good one, and finally he had to abandon this and sutured the two ends of the aorta to each other. The œsophagus was fully exposed and handled. The operation took about an hour and a quarter. The dog at no time was in the slightest apparent danger of death. The lungs were pink, and whenever it was deemed necessary a little more pressure was put on or the pressure was diminished at will, and finally when the operation was completed the lungs were considerably distended to displace all the air in the thoracic cavity, the walls of the thorax were sutured in layers, and in the course of two or three minutes after the conclusion of the operation the tube was withdrawn and the dog was breathing as naturally as if an abdominal and not a thoracic operation had been performed. Dr. Keen was very much struck at the time with the simplicity of the operation, with the possibility of doing almost any operation by means of this method. It is a vast improvement over the expensive differential pressure chambers. The usefulness of this apparatus will be broadened very much.

Dr. Charles H. Frazier said that he had recently witnessed

Fig. 1.



Giant appendix vermiformis.

a demonstration of this apparatus by Dr. Elsberg and he had been impressed with its effectiveness and the apparent freedom from risk. The operation, an appendectomy, was being performed by Dr. Elsberg's assistant. Dr. Elsberg gave his attention wholly to the apparatus which worked perfectly, and while it appears rather complicated, one should readily master its mechanism. It will replace general anæsthesia by the ether drop method in a number of instances, particularly in thoracic operations, in all operations in which the patient is in the prone position (face down) as well as in those about the buccal cavity where there is always danger of the possibility of the inhalation of blood with inhalation anæsthesia. Dr. Elsberg has shown by experiment that the force of the outgoing air is sufficient to prevent particles of blood, or as he used in his experiments lampblack, entering the trachea or bronchi. This is a very practical consideration and should not be lost sight of.

GIANT APPENDIX.

Dr. John A. Jopson showed a giant appendix vermiformis. The patient from whom he had removed it was a woman about fifty-eight years of age, exhibiting the symptoms of acute appendicitis, and who was operated upon the fourth day after the onset. The appendix was retrocæcal, pointing upward and adherent to the posterior surface of the cæcum and colon, and from its peculiar shape, size, and color, not easily recognized. It was separated from its attachment to the posterior wall of the cæcum, and when turned downward appeared as a large pouch communicating with the extremity of the cæcum, which was rather short. It lacked a mesentery, was white in color, and apparently undergoing necrosis, a sharp line of demarcation being present at its base. The base was crushed, ligated, divided, and the broad stump inverted by interrupted sutures. A drain was left in the wound to guard against leakage, but none occurred, and the patient, who suffered from chronic nephritis, made a good recovery. The appendix, which was quite empty, measured 7.5 cm. in length, by 4 cm. in diameter (Fig. 1). The wall was nearly a centimetre thick at the base, and there were two points of beginning perforation at the tip. Microscopic examination of sections was made by Dr. Speese, who furnished the following report: "The examination does not reveal any glandular tissue or any structure which is suggestive of the same. To some extent the section resembles the normal structure of the intestine, in that some lymphoid tissue is present and arrangements suggestive of the normal coats of the intestine. The outline of these areas is, however, greatly distorted, and the muscle tissue separated by granulation tissue, dense in structure and apparently of long standing. There is an organized exudate or what appears to be the serosa, and throughout the appendix blood-vessels are distended and leucocytic infiltration points to an acute exacerbation. It is noteworthy that many eosinophilic leucocytes are present in the tissues. The examination discloses a process which resembles the lesions of acute and chronic interstitial appendicitis."

The appendix in this case would seem to be a reversion to a primitive type, in which the differentiation between the cæcum and appendix was much behind that normally observed in the human subject. It was interesting to compare it with those observed in some of the lower animals, as figured in Huntingdon's diagrams, reproduced with additional drawings in Kelly and Hurdon's work. In their shape and proportions the cæcum and appendix in this case resembled somewhat those normally present in the aard-wolf, the harbor seal, the collared peccary, and the American tapir.

THE SURGICAL CLINIC OF THE PROTESTANT EPISCOPAL HOSPITAL.

Dr. CHARLES H. FRAZIER read a paper with the above title, for which see page 554.

CORRESPONDENCE.

SPLINTING SKIN GRAFTS AND GRANULATING SURFACES.

Editor Annals of Surgery,

Dear Sir: Supplementing the paper by Dr. John S. Davis in the March, 1909, issue of the Annals of Surgery, I may say that since October, 1906, it has been my practice to dress burns, ulcers, blisters, and skin grafts with a protective made by dipping Brussels net into a mixture which renders it non-absorbent. This allows any ordinary dressing to be used, as all discharge escapes through the openings of the mesh into the outer dressings, and the net itself adheres neither to the wound surface nor to the dressings.

The first mesh I used was made by dipping the net into a xylol solution of crown dental rubber, but during the past two years I have used a mixture of white wax, laundry paraffin, and turpentine. This is equally efficient and infinitely cheaper, does not deteriorate, and can be prepared with much less trouble.

An average formula is as follows: white wax, two ounces; laundry paraffin, four ounces; turpentine, two ounces. Melt the wax and paraffin together, then add the turpentine, and bring slowly to a boil, now dip the Brussels net (previously sterilized) into the boiling mixture, for if the net is dipped when the mixture is not boiling films of wax form across the openings. Place in a solution of mercury bichloride 1:100 until required for use. Before using wash with sterile saline solution (warm but not hot).

Simple as the material is, it saves an immense amount of suffering for the patient and time for the dresser. Mesh of different sizes will be required for different cases, and the proportions of the ingredients may be altered for different conditions.

H. H. Sinclair, M.D., C.M.,
Walkerton, Ont.

August, 1911.

OPEN TREATMENT OF FRACTURES.

Editor Annals of Surgery:

In the Annals of September, 1911, on page 407, there is attributed to me a statement in a discussion of Dr. Edward Martin's paper on "The Open Treatment of Fractures," read at the meeting of the American Surgical Association, which conveys an erroneous impression. I am made to say, "Equally good results can be obtained by the ordinary old-fashioned pulleys with Buck's extension."

I said that, instead of using a one hundred pound weight for reducing the opened fracture, as suggested by Dr. Martin: "Equally good results (in overcoming the over-riding before applying the plate and screws) can be obtained by the ordinary old-fashioned *compound* pulleys, attached to the limb with Buck's extension apparatus."

I at the same time reported a case, wherein I had used this method, because the ordinary Buck's extension method with pulley at the foot of the bed was valueless. The fracture was such as required me to open and use plates and screws.

Any practical surgeon will at once see the dissimilar significance of these two similar sentences. The first is untrue, the second is true, in my opinion.

Yours truly,

John B. Roberts.

313 S. 17th St., Philadelphia, Pa.

ANNALS OF SURGERY

VOL. LIV NOVEMBER, 1911 No. 5

ORIGINAL MEMOIRS.

ACUTE HÆMATOGENOUS INFECTION OF THE KIDNEY.

BY FREDERIC J. COTTON, M.D.,
OF BOSTON, MASS.

THAT the kidney may become infected by way of the blood stream is a fact long known, but it remained for Brewer[1] to bring to our attention a curious class of cases in which the hæmatogenous kidney infection does not imply a general pyæmic process, and to show that in certain of these infarcted infected kidneys there was no other gross septic lesion, and that the affected kidney was within reach of effective surgical attack.

With the appearance of his article, seven years ago, the infarcted septic kidney[2] resigned its pathological position as an exhibit, and "went surgical."

A new symptom complex, representing a definite lesion, open to attack, was presented to the surgeons.

I fear we have not taken full advantage of our opportunity. In 1908 Cobb presented an excellent series of eight cases, operated on at the Massachusetts General Hospital by himself and by certain of his colleagues, and reviewed the previous published data,[3] but since then the reports have been few and scattering. If we may judge by the published data of *demonstrated* cases in the hands of a few men, these cases cannot be very unusual.[4] They must have occurred in the practice of all of us. I confess that I have recognized no cases previous to those here reported, but as I look back I have an uneasy suspicion (amounting almost to a certainty in one case that went on to the formation of a perinephritic abscess) that I have seen such cases before, and have failed to recognize them.

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[1] G. E. Brewer: ANNALS OF SURGERY, 1904, xl, 1010.

[2] With all respect for Brewer, it seems to me that his "acute hæmatogenous infection" is a rather formidable title for daily use. May I suggest *septic infarcted*, or *infected infarcted*, kidney as a handier handle?

Believing that I am not alone in this matter, I present the two cases here reported, intrinsically not especially notable except perhaps for the happy outcome.

They are presented for three reasons:

1. All such cases should be reported until all surgeons are on the lookout for them.

2. These cases suggest a connection between kidney prolapse and the choice (if we may so phrase it) of the localization of the lesion, that seems not to have been noted previously.

3. They are examples of what may be done by *conservative* operation if cases are operated on early enough.

Case I.—Mrs. E. L., age thirty-nine years, married, multipara, entered Nov. 9, 1910, sent to the hospital by Dr. J. J. Fitzpatrick of Charlestown, Mass., who writes that he saw her Nov. 5, 1910. She then gave a history of an injury to her right side two years ago, the result of a fall, at a time when she was six months pregnant. There was no obvious interference with the following childbirth.

When he first saw her, she complained of irritation of the bladder and of pain in the lower abdomen and about the urethra.

Nov. 8, she complained of pain, and examination showed tenderness below the edge of the liver and over the right kidney.

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[3] Farrar Cobb: ANNALS OF SURGERY, 1908, xlviii, 680.

[4] Brewer, in his second article (Surgery, Gynæcology, and Obstetrics, 1906, ii, 485), was able to cite 13 cases, personally observed.

and there was complaint of pain also in the back, about the kidney.

Nov. 9, at 6 P.M., her temperature rose to 103° F., the pulse to 100, and she complained of chilliness and sweating, and showed marked soreness in the right flank. The urine showed a specific gravity of 1018, and albumin was present. There was diarrhœa with moderate vomiting.

Dr. Fitzpatrick referred her to the City Hospital with a diagnosis of acute nephritis, and she came to me with the admitting physician's diagnosis of appendicitis.

I saw her as an "emergency case" in the evening of Nov. 9, 1910. Physical examination was negative, except for moderate spasm of the abdomen as a whole, and tenderness over the right iliac region and in the right loin (costovertebral). The tenderness was most obvious over the appendix region, and the tenderness behind was not more than one often finds with a high appendix. The temperature was 103°, the pulse 120.

Vaginal examination showed nothing significant. There was a decided trace of albumin in the urine.

At the time I was not able to exclude an appendicitis, and consequently the first incision was made in front. Nothing abnormal was found save that the right kidney, obviously prolapsed, seemed larger than normal. The patient was turned over, and the conventional posterior kidney incision was made, and the kidney brought into view. Several whitish patches appeared, conspicuous against the background of a purple, congested, enlarged kidney. The capsule was split and reflected to either side, and a number of whitish areas stood out, dull white, outlined in purplish-black against a purple kidney. There was no pus. The white areas were obviously of embolic origin. The capsule was freely rolled back, and the infarcts cut into freely.

There seemed no reason for sacrificing the kidney, or for cutting deeper.

The rolled-back capsule was caught up (Edebohls's technic) and sutured to the muscle layers. A "cigarette" drain was left in.

There was no post-operative shock or other trouble, and four days later the records showed a temperature already fallen to normal, with a pulse of 86. The drain was still in, but there was no pus. The urine showed no albumin.

The drainage was removed on the ninth day. At no time was there any pus discharge.

Eleven days after operation the patient was "up and about," and the wound had healed solidly.

At this time the urine was of high color, slightly cloudy, specific gravity 1020, acid, very slight trace of albumin, no sugar. The sediment showed one coarse granular cast, some fine granular casts, some hyaline casts, epithelial cells (squamous only), and a few "compound granule cells."

The patient was discharged fourteen days after operation in good condition.

December 11, 1910, she entered the hospital on the gynæcological service to be treated for an incomplete spontaneous abortion. No note is made on the records of the service of any urinary complaint or renal complication, and no urine examination is recorded.

I did not see her again until February 14, 1911. At this time she had a fistulous track in the wound, which she said had developed in December. This later cleared up without any operation. At this time the urine showed no trace of albumin, and the sediment showed no renal elements. The kidney was firmly anchored, and was not abnormally tender. August 4, 1911, she reported in writing that she was well and in good condition.

Case II.—Mrs. N. M., age thirty-four years, widow; multipara; previous health fair, though she had been overworked. For about three weeks previous to admission to the hospital she had been feeling "out of sorts," though up to a week before admission she had no definite symptoms.

During the week previous to her entrance to the hospital she had been "miserable," with abdominal pain (not sharply localized) and she had a good deal of nausea. For two days she had had sharp pain in the right lower quadrant of the abdomen, with vomiting, and had been unable to work.

The day before she entered the hospital she vomited repeatedly, suffered from general abdominal pain and tenderness, and had to have recourse to injections to move the bowels.

Her physician, Dr. T. P. Fitzgerald, of Brighton, Mass., sent her to the Boston City Hospital on December 8, 1910, on which date I first saw her. She then showed some tenderness of the abdomen, with involuntary spasm of the muscles of the right lower quadrant. Deep palpation with both hands showed a mass, obviously the enlarged and prolapsed right kidney, which was abnormally sensitive to pressure.

At this time the temperature was 99.8°, the pulse was 90. The white blood count showed 12,000.

The urine was turbid, of acid reaction. Albumin was present to a total between 0.125 and 0.25 per cent. There was no sugar present. No casts were found.

On December 10 the temperature was registered 98.8°, the white count 10,000. Nevertheless the pain persisted, rather more localized toward the right groin. My examination on this date showed well-marked tenderness of the right lower quadrant of the abdomen. The costovertebral tenderness in this case was present, but was not very well marked.

All things considered, however, it seemed clear that we were dealing with a renal, not with an intraperitoneal, condition, and when an operation was decided on (December 10) the loin incision was used.

The kidney was readily found, but was found in a position of well-defined prolapse. It was brought out into the wound, and showed greatly increased intracapsular tension. There were mottled whitish areas at the lower pole, but no clean-cut infarcted patches. The kidney was cyanotic, swollen, and was markedly prolapsed. The capsule was split, was rolled back, and was sutured to the muscles as in the previous case.

December 22 (the twelfth day), the temperature and pulse had fallen to normal and no albumin was present in the urine. No pain. Wound healed solidly. "Up and about" for the past four days. Discharged from the hospital.

The urine in this case showed *after* the operation: specific gravity, 1025; albumin, a trace; red blood-cells, leucocytes, squamous cells, small round epithelial cells. Apparently not as many pus-cells as before the operation. Albumin less in amount.

A few days later, the analysis showed a specific gravity of 1020, a trace of albumin, leucocytes, small and large round cells, quadrate and squamous cells.

December 16, 1910: The urine was of a specific gravity of 1017, acid, with no albumin or sugar, with very few leucocytes, and very few squamous cells.

December 27: The wound was solidly healed. There was no pain, though the patient had been up and about for several days.

On March 1, 1911, this patient was seen in my office (in response to a letter of inquiry), and was found at this time in excellent condition. There had been no pain. There was no tenderness. The kidney was palpable in the position in which it had been moored, and was not abnormally sensitive to touch. A specimen of urine obtained was clear, of 1020 gravity, and without a trace of albumin. Her general health was improved and might be described as fair, though still showing undernutrition.

Since the body of this article was written, I have chanced to observe a case that may be of value by way of contrast, a case of hæmatogenous infection associated with a frank and fatal pyæmia.

Case III.—M. O'N., female, aged twenty-four years, married, previously healthy, was admitted to the Boston City Hospital March 20, 1911, under the diagnosis of gall-stones. She had been well until four days previous, when she began to menstruate, and (contrary to her custom) began to vomit and to have severe pains in the abdomen just below the ribs. The pain and vomiting persisted; on the second day she began to be jaundiced.

On the fourth day she entered the hospital, very sick, showing a slight jaundice, marked right hypogastric and costovertebral tenderness, and a slight systolic murmur over the heart.

Investigation showed, apart from the mentioned findings, a red count of 2,064,000 with a white count of 47,000. At this time she showed slight mental "fogginess." The urine showed albumin and few casts, nothing else.

Two days later the jaundice was less, the kidney tenderness was less, but the septic temperature and the septic anæmia persisted, and all means employed to check a hiccough which had developed had failed.

March 24, the local symptoms were less, the kidney evidently smaller and less obviously tender, but her condition in general was not improved.

March 27: Local signs less, but condition worse. Hiccough severe; vomiting occasional, but cannot be checked.

For 24 hours, more or less, she had been failing. At 4.30 P.M. she suddenly grew worse, and died within a few minutes in such fashion as suggested a terminal pulmonary embolism. No autopsy could be obtained.

This case showed a general sepsis. Dr. Libby (who examined her in consultation with me) found endocarditis, pericarditis, and a probable central pneumonia, beside the kidney lesion.

The case is brought up simply for contrast: it was a case of general sepsis with a kidney lesion apparently unilateral, but, owing to the generalized septic process, entirely beyond surgical reach.

The first case calls for little comment. It is typical for an early case of the type originally described, except for the complication of the floating kidney.

In the second case it may fairly be objected that no definite infarcts were found. Nevertheless, a septic infection of central origin seems clear from the clinical picture of sepsis presented, promptly and permanently relieved by relief of the extreme congestion found at operation. Engorgement alone will not account for the septic picture.

Whether such a case is a pure diffuse infection, or whether if left longer it would show localized infarctions, I do not know.

It is of interest that both cases were in "floating" kidneys, considerably displaced. In all the series so far recorded there is noted a preponderance of females over males, of multiparæ over nulliparæ, of infections of the right as against the left side.

No one seems to have noted, however, that all these differences coincide exactly with the conditions predisposing to *displacement* of the kidney.

My cases both showed definite displacement of the infected (right) kidney—how many previous cases showed the same condition is a question not to be answered from the records. It is at least a striking coincidence, and perhaps more than that.

May there not be an explanation here of the point that has puzzled all the writers on this subject, namely, why the kidney (and the kidney only) should be the picked site of localization for an infection that must primarily have been a general blood infection?

If I am right in this surmise, then the operation done in these two instances represents an improvement in technic (in the earlier cases at least), for it must not only relieve tension and provide drainage, but must also relieve the abnormal position which is a cause of poor circulation and of abnormal intracapsular tension.

The recorded series of cases is too short to warrant any very positive conclusions, but it does seem undesirable to sacrifice a kidney because *part* of its substance is gone, if we can by any safe means save the rest of it.

In the later and severer cases the kidney may be past saving. In the earlier and simpler, and in the doubtful cases, it seems to me worth while to try and save what we can. Nephrectomy is easy and can be done later, if need be.

May it not be wise, in the doubtful cases at least, to try the measures of wide decapsulation, suspension, and drainage, that worked out so fortunately in the two instances here noted?

MALIGNANT PAPILLARY ADENOMA OF THE KIDNEY.*

BY J. BENTLEY SQUIER, M.D.,
OF NEW YORK.

The large variety of renal tumors which have been histologically differentiated is evidenced in Küster's classification. Including those of the kidney proper, the capsule, and the adrenal, twenty-six distinct types are mentioned. Among these, malignant papillary adenoma is of sufficient rarity to justify the presentation of this patient and kidney specimen.

In a series of 529 cases of renal tumors, Albarran and Imbert found only thirteen malignant adenomata. Eisenstaedt, after a careful search of the literature, found one absolutely proven case, that of Sudeck in 1892, in addition to the one reported by him.

The history of the case which I desire to report is as follows:

The patient, a carpenter, forty-three years of age, appeared at my clinic March 9, 1911.

On December 1, 1910, while lifting a heavy weight, he was seized with severe pain in the left inguinal region, which radiated to the left lumbar region. A desire to urinate was present, and upon voiding, blood in large amount was noticed. For one week he was confined to his bed. During this time, the pain continued, he vomited frequently, and the hæmaturia slowly disappeared. At the end of the week, all symptoms had cleared up, and one week later he went back to work.

He was then without symptoms until February 1, 1911, when, on lifting a heavy weight, the symptoms returned. During this attack, several finger-like clots of blood were voided. The passing of the clots caused severe tenesmus. The duration of the attack was six days.

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* Read before the American Association of Genito Urinary Surgeons, June 2, 1911.

When he appeared at the clinic, he had had no symptoms for four weeks, with the exception of an occasional sensation of weakness in the left lumbar region. His past history was negative, except for some irregular gastro-intestinal symptoms extending over a period of years, such as flatulence, sense of weight in epigastrium, and constipation. He had always been a hard working man, and did not remember ever having had serious illness. His mother had died of some form of cancer.

Physical Examination.—Medium frame, fairly well nourished, skin and mucous membrane good color, no adenopathy, chest normal, abdomen negative, kidneys not palpable. Rectal examination negative. Cystoscopy showed a normal bladder, prostate, and ureteral orifices. Ureteral catheterization collected normal urine from either kidney. Radiographic examination of kidneys did not aid diagnosis.

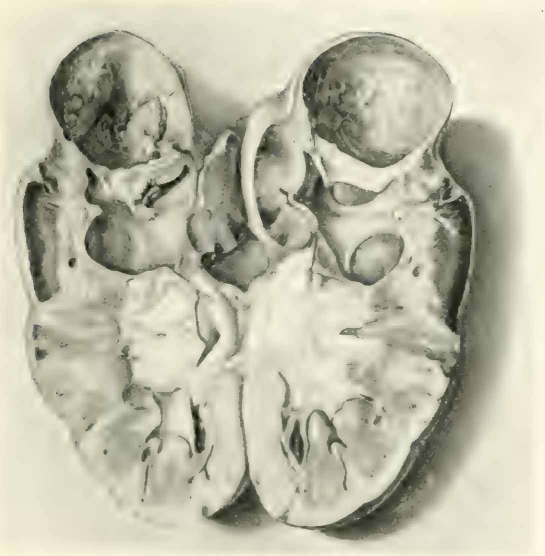
In view of these negative findings, the patient was sent home to be observed by his family physician. On March 18, a recurrence of the hæmaturia took place lasting two days. He was admitted to the hospital on March 21, and upon the following day, left nephrectomy was performed through a vertical lumbar incision. There were many adhesions about the upper lobe of the kidney. The wound was closed about a rubber tissue drain.

Convalescence from the operation was uneventful; the drain was removed at the end of 48 hours; the wound healed by first intention. He was out of bed at the end of a week, and left the hospital on April 3.

Pathological Examination.—Specimen: Kidney examined after fixation in formalin and opened by a longitudinal median section. At one pole there is a globular cystic cavity whose wall, in the hardened state, has a yellowish color, being thin over that portion of its extent which projects beyond the kidney parenchyma. The exposed portion of the wall of the cavity measures between 2 to 3 mm. in thickness, and the cavity is filled with yellowish granular material. Where the cyst is imbedded in the kidney substance, a soft, friable, narrow layer of grayish tissue separates it from the pelvis which is dilated at that point (Figs. 1 and 2).

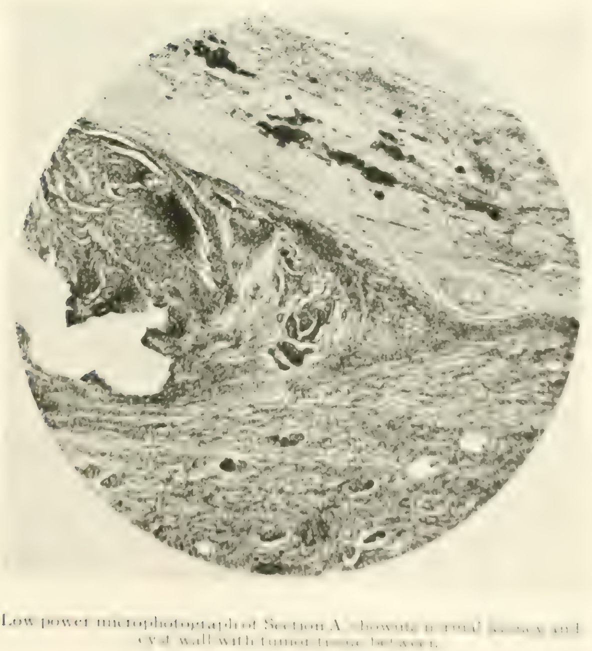
Section A: Sections, including that portion of the wall of the cyst which is imbedded in the parenchyma of the kidney, present the following picture: The cyst wall is made up of a zone of connective tissue with numerous areas of lime deposit. The kidney parenchyma is bounded by this layer, except at one point where there is a tumor tissue just outside of the cyst wall, between the kidney tissue and the fibrous

Fig. 1.



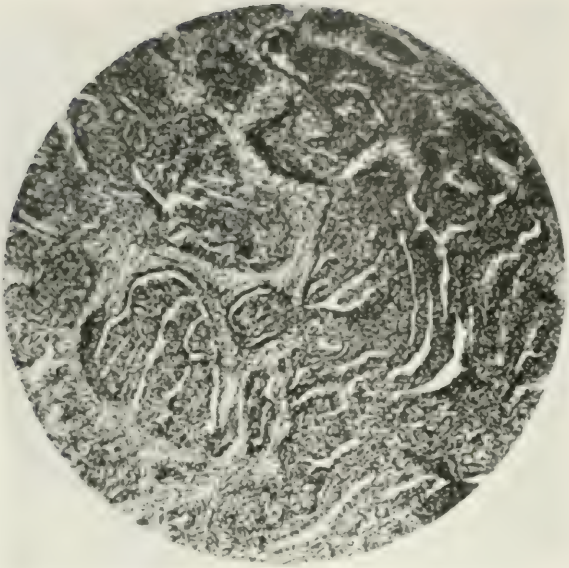
Malignant papillary adenoma of kidney.

Fig. 3.



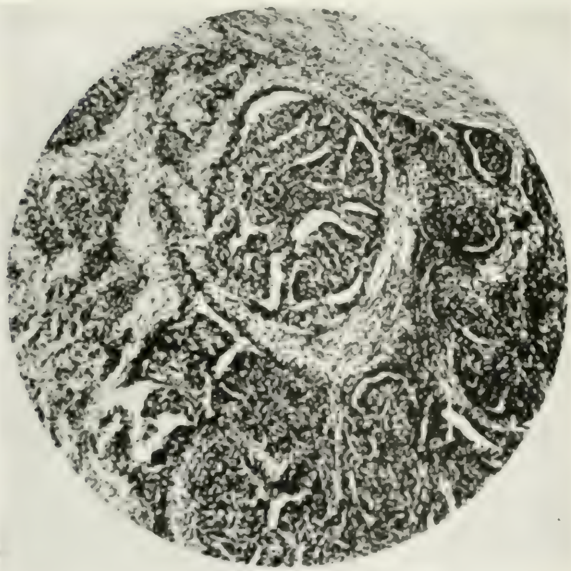
Low power microphotograph of Section A, showing normal kidney and cyst wall with tumor tissue between.

Fig. 7.



Low power microphotograph of tumor tissue

Fig. 8.



High power microphotograph of tumor tissue membrane just described. Attached to and partly separated from the inner aspect of the cyst wall is some necrotic material, including slits that doubtless were filled with cholesterin crystals. These crystals must have been imbedded in a degenerate cyst content, the nature of which cannot be definitely ascertained, but which probably represents broken down tumor tissue, in view of the fact that the shadows of cells can be distinguished. At a point corresponding to those areas of the gross specimen which presented the yellowish material previously mentioned, there is a layer of papillary adenoma in which the proliferative phenomena, multiplication of cells, and formation of solid nests are sufficiently well marked to warrant a diagnosis of malignant adenoma. For the most part in this area there are slender, tuft-like outgrowths, covered with cuboidal and polygenal cells, communicating and fusing with solid masses in a manner characteristic of those adenomata that show a transition into a medullary type. In the area outside of the cyst and next to the kidney parenchyma there is a similar papillary tumor. The kidney tissue itself at this point shows marked atrophy, foci of round-celled infiltration, and degeneration of glomeruli (Figs. 3, 4 and 5).

Fig. 2.

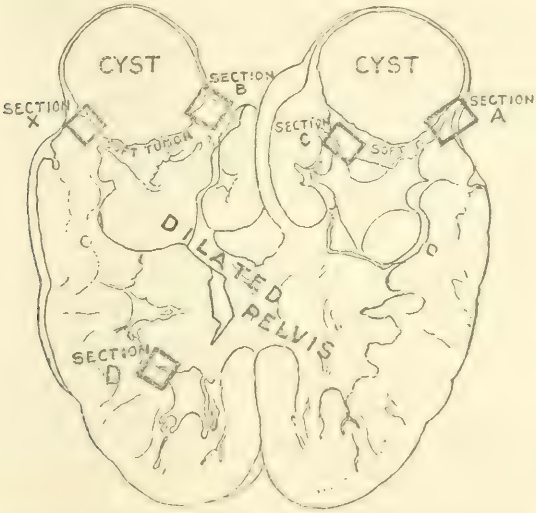


Diagram showing locations of sections examined microscopically.

Section B: Another section taken from the border of the cyst shows only a minute area of papillary tumor in the fibrous wall itself.

Section C: Sections made from the soft tissue just outside of the cyst wall show papillary adenoma undergoing marked degeneration. In this specimen where the papillary outgrowths are not so crowded the cells take on a high cylindrical form.

Section D: A piece of the wall of the pelvis of the kidney shows moderate thickening, due in part to a submucous inflammatory process and œdema.

Diagnosis.—Cystic tumor of the kidney, in the wall and outside of which is a papillary malignant adenoma. Owing to the dense fibrous nature of the cyst wall, with its calcareous inclusions, it must be assumed that the cyst is the older lesion; that it may originally have harbored a benign papillary adenoma which has since become malignant (malignant adenoma), and is invading both the fibrous tissue wall of the cyst and the parenchyma of the kidney.

Since leaving the hospital and returning to work, there has been a continuance of the gastro-intestinal symptoms.

Considering the possibility of metastasis in the stomach, a series of X-ray plates were made of the stomach on May 25. The findings were as follows:

Stomach is of the cowhorn type. Size: Normal.

Position: Slightly prolapsed, the greater curvature being on a level with the umbilicus, the pylorus 1½ in. above and to the right of the umbilicus.

Peristalsis: Of the 4-wave type, moderately active and equal in greater and lesser curvatures, not interfered with by adhesions or new growth of the wall of the stomach.

The first portion of the duodenum, which usually appears as a triangular cap, has more the appearance of a brass button on a steer's horn when the stomach is of this type. This triangular cap or button is separated from the pyloric end of the stomach by a space 3/16 of an inch, which indicates the normal pyloric sphincter.

Diagnosis.—From a study of these plates, one is justified in stating that the stomach is of the size, shape, and position as described in the findings, moderately active, motor phenomena of the 4-wave type, with no evidence of new growth of or pressing on the stomach.

Conclusion.—The malignant papillary adenoma was probably primary in the kidney and localized.

POLYP OF URINARY BLADDER IN A THIRTEEN MONTHS OLD CHILD.

WITH A REVIEW OF THE LITERATURE.

BY IRVIN S. KOLL, M.D.,
OF CHICAGO.

THE rarity of vesical tumors in young children makes the subject one of the most interesting in genito-urinary surgery. Not only is the interest from a surgical and clinical aspect, but also from the pathological picture, which is quite varied. Mandelbaum[1] conveniently classifies neoplasms of the bladder according to their origin: (1) epithelial tissue group: papilloma, adenoma, carcinoma, cysts, polyps; (2) connective-tissue group: fibroma, myxoma, sarcoma; (3) muscle tissue group: myoma.

This division is more or less used with some variation in many of the pathological reports reviewed, covering the past twenty-eight years of literature.

In 300 cases of bladder tumor which came to operation, Von Frisch[2] reports only three in children—nine, eleven and thirteen years of age. All three of them were papillomata. Davis's[3] youngest patient was sixteen years of age, in thirty-seven cases operated. Rumpel[4] reports a case of myxofibroma in a male, three years of age, successfully operated, with no recurrence at the end of six months. Steffen[5] has compiled thirty-one cases, covering a period of twenty-two years. Most of the specimens were obtained at autopsy. All of the thirty-one cases died. Twenty-one were sarcomata, one papilloma, nine myxoma. Fifteen of the cases were in males, sixteen in females. The average age was five years; the youngest eleven months (sarcoma), the oldest twelve.

Hüsler[6] cites fourteen cases collected by Steinmetz, from the European clinics, from 1893 to 1905. The average age was five and one-half years; the youngest one and one half, the oldest twelve. Ten of the fourteen occurred in males. Seven of the tumors were benign, seven malignant. Of the benign he gives the following mixed classification: 2 fibroma-œdematosum, 1 fibrorhabdomyoma, 1 myxorhabdomyoma, 1 myxoma, 1 papilloma. The seven malignant tumors were all sarcomata.

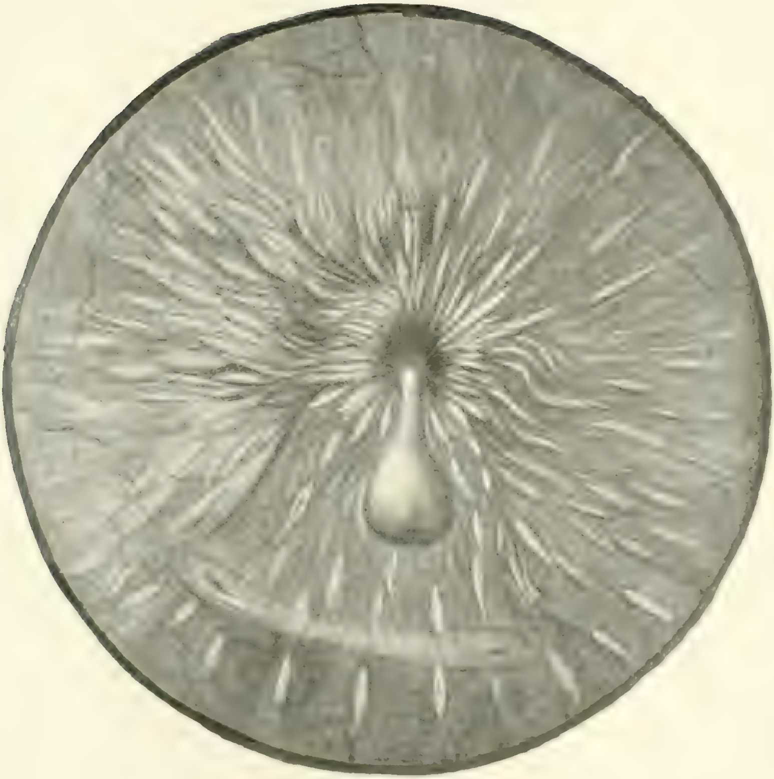
Half of the number submitted to operation. Of these only three recovered; one had a recurrence one and a half years later, with fatal issue.

Clinically, the manifestations are more or less similar in all the cases. Two of Hüsler's cases, briefly cited, are as follows:

> Male, one and one-half years; normal delivery. When four months of age mother on one occasion noticed a few drops of blood at end of urination. There followed a gradually increasing painful and difficult urination. An œdema and swelling of the external genitals developed; then suddenly complete retention, with a rapidly succeeding uræmia, and death. At autopsy an œdematous tumor mass, the size of a small apple, was found apparently springing from the urethral mucosa.
>
> The second case was a male, seven years of age, whose mother, six months prior to his entrance to hospital, noted that it took the child a long time to urinate, and that the urine came away in dribbles. Later the patient began complaining of a sticking pain and burning when passing his water. This increased, when suddenly there was complete retention. Only once a small amount of blood was seen. A soft rubber catheter introduced into the urethra encountered a slight resistance at the entrance to the bladder. Per rectum under anæsthesia, a movable mass was palpated in the fundus of the bladder, which was about the size of a plum. Operation was refused. Obstipation developed; sudden perforation of bladder into rectum. Exitus. Autopsy showed a tumor of the size described obstructing the right ureteral orifice and extending up into the fundus. Microscopic diagnosis was myxoma-papillare.

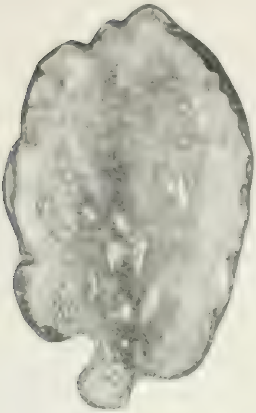
The writer's case was sent to him by Dr. Lester E. Frankenthal, who had seen the patient in consultation with Dr. H. H. Frothingham. The mother gave the following history: From birth, which was instrumental, the patient, now thirteen months old, has been in perfect health up to one week before entrance into Michael Reese Hospital. At this time the mother noted that the child had not urinated for some hours and was crying, evidently from pain. On looking at his abdomen, she thought it appeared distended, and then sent for Dr. Frothingham, who

FIG. 1.



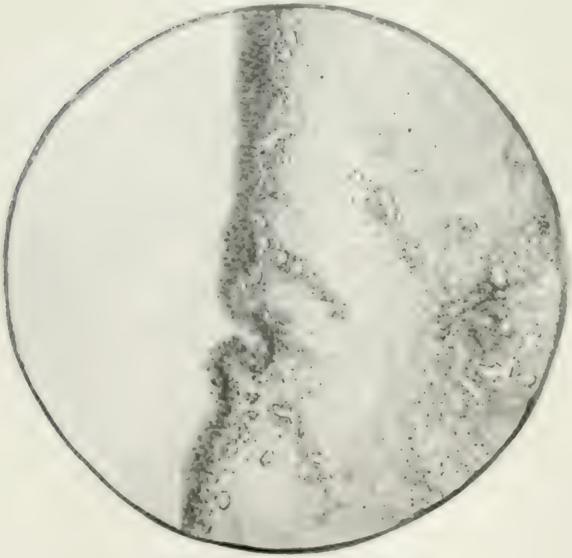
Polyp attached to internal urethral orifice.

FIG. 2.



Outline of tumor. Section through pedicle. × 20.

FIG. 3.



Structure of tumor. × [illegible].

catheterized the patient and obtained a large quantity of turbid urine. For a short time the child urinated small quantities, then again there was complete retention.

When I first saw the patient he was in great pain, the fundus of his bladder reaching as high as his umbilicus. There was a marked phimosis, with a very long prepuce. Catheterization yielded 300 c.c. of slightly turbid urine which, upon examination, showed a great many leucocytes, no blood and, culturally, a pure strain of colon bacillus. Upon passing the catheter a distinct obstruction was encountered at the internal urethral orifice, which, however, promptly allowed the catheter to pass into the bladder.

Cystoscopic examination showed only a slightly inflamed mucosa, no calculi and no neoplasm was seen. At no time was there any hæmaturia.

Circumcision and permanent catheter for forty-eight hours did not relieve the retention. At intervals it was noted that the patient would urinate a few drops, then suddenly stop, and he would use a great deal of abdominal muscular force in the vain attempt to empty his bladder. Rectal examination was negative. Careful exploration with a sound again encountered the resistance at the internal urethral orifice. The diagnosis of obstruction due either to some congenital malformation or a new growth was made, and consent for an operation was obtained.

The typical suprapubic incision was made. When stripping back the peritoneum a marked hypertrophy of the musculature of the bladder was very evident, and the bladder itself was about three times its normal size. As soon as the bladder was incised and the walls retracted, a tumor mass was seen, about the size of a small hazelnut, lying just below the internal urethral orifice (Fig. 1). This was smooth, had two lobules, and was attached by a pedicle, about 2 cm. in length, which sprang from the mucosa lining the posterior wall of the urethral orifice. This relation explains how it was that the patient could at times pass a small amount of urine, then have a sudden stoppage—a typical ball-valve action. The connection to the urethral mucosa also explains why the tumor could not be seen with the small cystoscope, but probably would have been visible had it been in an adult.

The growth was grasped in a pair of forceps and twisted off its pedicle, this procedure being considered preferable to having any ligature material lying in such an undesirable position. There was no bleeding from the stump. The bladder was closed completely with two rows of running plain catgut. A very small fistula developed on the fifth day, which very promptly closed, the wound healing by primary union. Spontaneous urination took place immediately following the operation, and the convalescence has been uninterrupted.

The pathological report is that of a simple polyp, covered by a layer of stratified squamous epithelium, continuous with that of the mucosa of the urethral orifice and bladder. Magnification twenty times shows the outline of the tumor, with section through the pedicle (Fig. 2). Magnification 103 shows the structure of the tumor under a higher power (Fig. 3).

REFERENCES.

[1] F. S. Mandelbaum: Pathology of New Growths of Bladder, Surg., Gynæc. and Obst., 1907, v, p. 315.

[2] V. Frisch: Bericht uber 300 Operierte Blasentumoren, Wien klin. Woch., 1907, xx, p. 1205.

[3] Lincoln Davis: Primary Tumors of the Urinary Bladder, ANNALS OF SURGERY, Phila., 1906, xliii, p. 556.

[4] Rumpel: Über kindliche Blasentumoren, Deut. med. Woch., xxxiv, p. 1855.

[5] A. Steffen: Die malignen Geschwülste im Kindesalter, pub. 1905 by F. Enke, Stuttgart.

[6] G. Husler: Beitrage zur Lehre von den Harnblasengeschwülsten im Kindesalter, Jahrbuch f. Kinderheilkunde, 1905, lxii, p. 133.

[7] Guizy: Trois Cas de Tumeurs de la Vessie sans Hematurie, Ann. d. Mal. des Org. Gen.-Urin., 1907, xxv, p. 103.

INTRAPERITONEAL OPERATION FOR EXTENSIVE CARCINOMA OF THE BLADDER WITH NEW METHOD OF TREATING THE DIVIDED URETER.

BY PAUL M. PILCHER, M.D.,

OF BROOKLYN, NEW YORK.

THE following case came to our private hospital for treatment through the courtesy of Dr. John W. Poole, of Brooklyn:

CASE REPORT.—A woman, sixty-two years of age. Family and previous history negative. Her first intimation that anything was wrong was the appearance of a small amount of blood in the urine ten months before consulting us. This means that the bladder involvement had already reached some advancement at that time. Blood continued to be passed in the urine at intervals, with some periods when no trace of blood could be found. Latterly the amount of blood in the urine has greatly increased, although it is absent at times. There was only occasional increased frequency of urination. Lost considerable weight, but still an obese, thick-set woman. No symptoms referable to either kidney.

Cystoscopy.—Right ureter opening (ostium) normal. Right kidney function normal, as shown by the phenolsulphonephthalein test (12 minutes).

Left ureter opening swollen and distorted, and seen to be involved in a carcinomatous growth. The opening itself was crater like, being surrounded by a raised up cauliflower growth.

The left ureter opening, the left wall of the bladder, a portion of the trigone, some of the anterior wall, and an area extending around the urethral orifice were seen to be involved in the malignant growth.

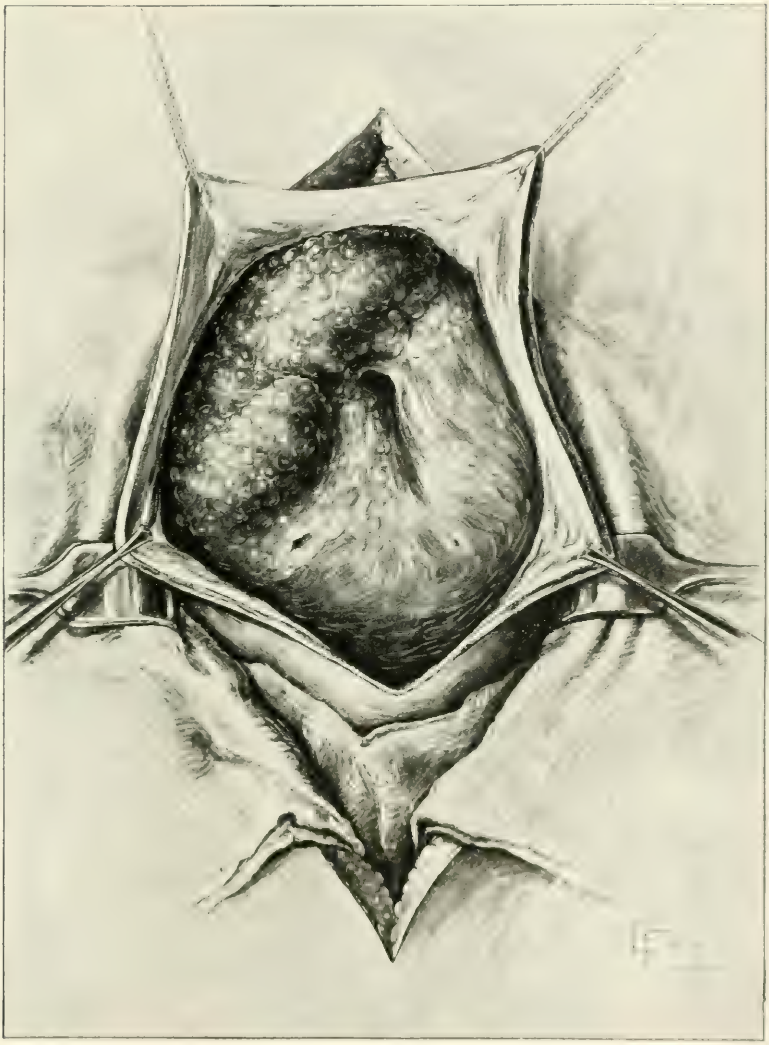
A vaginal examination revealed a distinct, hard mass occupying the vesicovaginal septum, about two inches in length by one inch in width. It did not involve the vaginal mucous membrane. Every one will recognize the extent of the lesion which was to be dealt with.

Operation, April 21, 1911, by the writer, assisted by Dr

Lewis S. Pilcher and Dr. James T. Pilcher. Incision from umbilicus to symphysis; peritoneal cavity opened; Trendelenburg posture; pelvis emptied of intestines and protected by gauze pads; bladder widely opened in the median line and growth well exposed. Using scissors, the bladder wall which was involved was detached from the healthy bladder wall down to the urethral opening and the left ureter opening. At the point of exit of the left ureter it was found that the growth was superficial, having extended along the mucous membrane without involving the deeper structures. It had not apparently extended into the lumen of the ureter. The mucous membrane, the submucous structures, and a portion of the muscular tissue surrounding and underlying the left ureter opening including all of the tissues involved in the malignant growth, were freed and dissected up, the ureter itself not being cut across. By using traction on the flap which had been separated it was found that the ureter was loosened from its sheath within the bladder wall and could easily be pulled down through the bladder wall. In this particular case over two inches of normal ureter were drawn through the bladder wall into the interior of the bladder. The question of what should be done with the ureter was next to be solved. It occurred to me that a great deal of time would be saved and danger avoided, if, instead of transplanting the ureter, the ureter should be cut across *in situ*, about an inch from its ostium, and simply be allowed to slip back into place. This was done, the lumen cut across and the end split up about one-quarter of an inch to avoid narrowing the outlet by cicatricial contraction.

My theory was this: Having removed the lower inch of ureter and a portion of the interior of the bladder there would remain an interval of from one-half to three-quarters of an inch between the cut end of the ureter and the interior of the bladder. The bladder musculature having been injured, and the bladder being kept empty for three or four days, would offer very little resistance to the efflux of urine from the ureter along the avenue of least resistance, the course of the ureter through the bladder wall being changed from an oblique one to a much shorter and more direct one. Experience with ureterovaginal, uretero-abdominal, and other ureteral fistulas has taught that if we have an unobstructed ureter, then a shell of other tissue forming a sinus and then a surface lined with mucous membrane, and no other outlet for the

FIG. 1.



An extensive growth is shown after opening the abdomen, packing off the pelvic viscera with gauze and freely opening the bladder by a vertical incision including the anterior and superior surfaces of the bladder. It will be noticed that the growth involves the left side of the bladder, more superficially the ostium of the left ureter opening and the first portion of the urethra. This growth also involves the vaginal septum, but not the mucous membrane of the vagina.

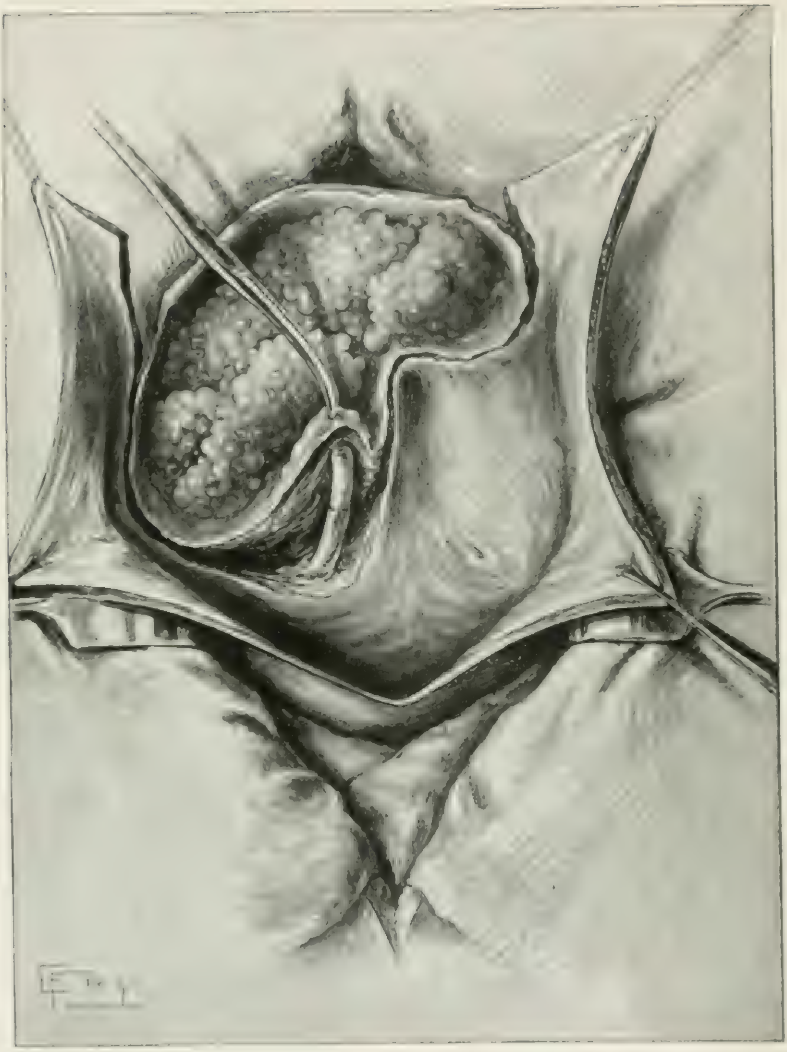


Fig. 2 shows the area of the bladder which was removed at operation including the entire growth, most of the left lateral portion and inferior portion of the bladder, the left ureter opening and a portion of the urethra. The area above the left ureter opening has been dissected up. Here the growth was superficial. In raising up this portion of the bladder wall, including the opening of the left ureter, it was noticed that the ureter itself was pulled through the bladder wall, and about two inches of the lower end of the ureter extended into the wound, free from carcinoma. Instead of transplanting the ureter, it was cut across as indicated in the drawing by a transverse and vertical line about an inch from its ostium, and the severed end of the ureter was allowed to slip back into place, after the end had been slit up about one-quarter of an inch to avoid narrowing of the outlet. There remained then an interval of one-half inch between the cut end of the ureter and the interior of the bladder, and a ureterovesical fistula was established.

urine from the ureter, the establishment of a fistula along this avenue is absolutely certain. I made use of this knowledge in the present case and intentionally formed an *ureterovesical fistula.*

After all the cancerous tissue had been removed, including much of the surrounding tissues beneath the symphysis, a portion of the anterior vaginal vault and all but a section of the urethral orifice, the bladder was reconstructed. The vesicovaginal opening was not closed and a rubber drainage tube was led through it from the bladder to the vagina. The anterior and lateral walls were brought together first by a running Connell suture of catgut and reinforced by a running Lembert suture of catgut. The intraperitoneal portion of the bladder was closed by a separate suture and reinforced a la Mayo. The peritoneal cavity was closed without drainage. The suprapubic portion of the wound was closed with the exception of a cigarette drain behind the symphysis. A second drain of rubber tubing was brought out beneath the symphysis and to the left of the labium majus. The bladder had in this way been entirely closed excepting at its base in the region of the trigone and to the left of the urethral orifice, which could not be entirely covered in but which was satisfactorily drained by the tube in the vagina. The left kidney discharged its urine via the left ureter, then through the ureterovesical fistula into the bladder.

The patient made an uneventful operative recovery. There was no leakage of urine excepting through the vesicovaginal opening. The drainage tube was removed from beneath the symphysis on the third day; from the suprapubic opening on the fourth day; the vesicovaginal tube on the fifth day. At no time was there any symptom referable to the left kidney. She passed urine *per urethram* on the tenth day. The leakage *per vaginam* ceased about the sixteenth day. She left the hospital on the thirty-first day, completely recovered.

I appreciate that the first criticism which would be offered would be that the bladder musculature would contract and stenosis around the vesical orifice of the fistula take place. Our experience, however, in cases of prostatectomy in which a comparatively large section of the prostatic urethra has been entirely removed without the development of any obstructive stricture at the vesical outlet led me to hope that a similar process would protect the ureterovesical opening.

The experience gained in this case has led me to theorize as to the possibilities of attacking the lower end of the ureter through the bladder, not simply to remove calculi, as has been so frequently done, but in the treatment of strictures of congenital origin or any disease involving the lower end of the ureter which does not involve the peritoneum. It is essential to my mind that the peritoneum should be intact, for, even if a relatively large portion of the ureter were removed or stripped out from its peritoneal covering, the tunnel thus left would suffice to convey the urine to the bladder and form an ureterovesical fistula. Knowing how difficult it is, oftentimes, to cure an ureteral or a vesical fistula of accidental origin, I think we would be justified in taking the chance of the fistula remaining patent. I believe that the chances of this are just as good, and not attended by so many chances of failure, as in ureteral transplantation in the hands of the majority of surgeons. In the only case of transplanted ureter which has come under my observation, post-operatively, I found that no urine was entering the bladder from the corresponding kidney.

SPLENECTOMY FOR RUPTURE OF SPLEEN.*

WITH REPORT OF FOUR CASES.

BY JOHN C. McCOY, M.D.,
OF PATERSON, N. J.

SPLENECTOMY is indicated in certain pathological conditions affecting the spleen causing an enlargement of the organ, interfering with the health of the individual, or for the reason that an enlarged spleen is a source of danger to the patient, owing to its susceptibility to laceration from trauma or even rupture without external violence.

The hypertrophy may be due to various pathological changes in the spleen substance, or the enlargement may be the result of systemic or infectious processes. Among the former causes may be mentioned: tumor of the spleen due to cysts, parasitic and non-parasitic; malignant growths, usually sarcoma, either primary or secondary; benign growths; abscess of the spleen, and contusion. No well-authenticated case of primary carcinoma is recorded.

Of the systemic and infectious conditions giving rise to enlargement of the spleen are malarial and syphilitic spleen; amyloid spleen; hypertrophy of the spleen with cirrhosis of the liver, and tubercular spleen. It has been generally accepted, that tuberculosis of the spleen never occurs as an independent condition, but is usually secondary to a general tuberculous process, and in itself is of very little clinical importance. So far as a differential diagnosis between a tuberculous enlargement of the spleen and a hypertrophied spleen from other pathological conditions is concerned, I believe the differentiation would be impossible in the absence of tubercular symptoms in other organs. That it is possible to have a tubercular condition present in the spleen with no apparent tubercular process elsewhere in the body, is illustrated in one of my cases.

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* Read before the New Jersey State Medical Society, June 15, 1911

The spleen may be classed as one of the blood-producing organs, and probably takes an active part in disposing of the broken-down blood-cells. How far it may exert an inhibiting effect, acting in the capacity of a mechanical filter, upon organisms entering the circulation, we cannot say. It has been claimed that patients from whom the spleen has been removed are more susceptible to infection. In no cases reported, however, has the removal of the spleen been followed by conditions which could be attributed to its absence. As to the effect upon the economy the extirpation of the spleen has, it is hard to say. It would seem that in those cases in which there were no marked pathological changes in the organ, there is no detrimental effect in the individual as the result of the removal of the spleen.

In two of my cases of extirpation following traumatism of the spleen, which have been carefully followed since operation, in the one case for a period of 16 months and in the other for 7 months, the general condition of the patients seems to have remained as good as it was prior to the loss of the organ. Both patients have steadily gained in weight, are able to indulge in athletic sports, and show no evidence of fatigue, even under severe exertion. Blood examination demonstrated a practically normal condition, 16 and 17 months respectively after splenectomy. It has been noticed in both cases, that though there has been a steady gain in flesh, and an excellent capillary circulation, giving an almost florid complexion, there is a faint but evident underlying bronze hue to the skin over the entire body, resembling the early stage of hæmatogenous jaundice of pernicious anæmia. Could this be explained on the basis of the absence of the spleen, which prior to its removal had disposed of the broken-down cell elements of the blood? We know from animal experimentation, and observations upon the human subject, following the removal of the spleen, that its presence is not essential to life; neither does its extirpation seem to interfere with the physical well being of the individual.

As to how far other parts of the economy, such as the bone-marrow or lymphoid tissues, take on increased activity after removal of the spleen, is not definitely known. There has been observed in some instances, after splenectomy, a general enlargement of the lymphatics and enlargement of the thyroid. We know that during fetal life, the spleen forms red blood-cells, this function being probably stopped at birth. It has been stated that the bone-marrow assumes increased activity upon removal of the spleen and compensates for its absence.

In cases of rupture of the spleen, in which extirpation has been done, the observations and subsequent blood examinations would seem to show that the changes in the blood elements were more marked and permanent than would be expected from the simple loss of blood. From our own investigations, it would seem to be only a question of time, when the blood constituents again reach a normal state.

Certain changes in the blood appear to be constant following splenectomy: (1) an increase in the number of white blood-cells; (2) a diminution in the number of red-cells; (3) an increase in the number of eosinophiles; (4) a disproportionate and more persistent diminution in the hæmoglobin.

Cases of rupture of the spleen are not common, 160 cases having been reported up to 1908. A large percentage of ruptures have occurred in pathological spleens, mostly in spleens enlarged from malarial or infectious conditions.

During the past three years, I have seen four cases of rupture of the spleen, two of which could be attributed to direct violence. The spleen was removed in each instance with one fatal result, that of the gunshot case.

The first case was one of gunshot wound of spleen. Case II was one of contusion of an apparently normal spleen, with subsequent rupture. Case III was one of contusion of a malarial spleen, with subsequent rupture. Case IV was a spontaneous rupture of a tubercular spleen with absolutely no history of trauma, appearing in a patient while in bed asleep.

CASE I.—Mrs. M., age thirty-eight. Seen in consultation with Dr. George Fisher. During a period of mental depression, placed a 32-calibre revolver against the left hypochondriac region and discharged the ball into the abdomen.

Physical Examination.—Large robust woman, married. Heart and lungs normal. Very fat abdominal wall. Pelvic examination negative. Perforating wound just below the free border of the ribs on left side three inches to the left of the ensiform cartilage, skin surrounding wound showing powder marks. Perforating wound just below border of ribs in anterior axillary line of left side, evidently point of exit of bullet. Abdominal wall rigid on right side and sensitive to pressure over left hypochondriac region; most marked just between the ribs. Temperature 98°; pulse 90, and there was nothing apparently alarming about her condition.

During the next 48 hours, the abdominal rigidity became more marked, distention more pronounced. There was evidence of general peritonitis. At end of 48 hours, temperature 102°, pulse 120; vomiting. Urinalysis negative.

Operation.—Median incision, free blood in peritoneal cavity, general peritonitis, rupture of the spleen, bullet having passed directly through the organ. Splenectomy. Death in 36 hours.

PATHOLOGICAL REPORT BY DR. F. R. SANDT.

The organ was but slightly increased in size, it was firm to the touch, the capsule was normal, the surface smooth, and the edges sharp. One portion of the organ, about one-fifth of it, was completely detached by the passage of a bullet and the rupturing effects of the resulting hemorrhage. Microscopical sections gave no pathological changes except in area close to injury, where there was an extensive hemorrhagic infiltration of the splenic tissue.

As stated, it has been claimed that tuberculous enlargement of the spleen *per se* does not occur. Dr. W. J. Mayo in 1909 reported a case of splenic tuberculosis, in which, other than the enlarged spleen, the physical examinations were negative. I wish to add the following case of splenic tuberculosis terminating in spontaneous rupture of the organ, occurring in a woman, who up to the time of the rupture of the spleen had been in her usual health, and showed no evidence of tubercular infection after the removal of the spleen.

Case II.—I am indebted to Dr. Rush Neer, with whom I saw the case in consultation, who had the case under observation for two days before admission to the hospital, for the following statement: "Patient went to bed Feb. 7, 1909, feeling perfectly well. About 4 or 5 A.M., Feb. 8, awoke suddenly with severe abdominal pain. When seen by me, the abdomen was distended, dulness on both sides, especially painful over left curvature of the colon. Purgatives administered and hot stupes applied to the abdomen.

"Feb. 9, several evacuations of the bowels, less abdominal distention, less pain. Vomited. Temperature 99.6°; pulse, 104.

"Feb. 10, temperature 99°; pulse 120. Severe abdominal pain, more distention."

Seen in consultation with Dr. Neer, Feb. 10, 2 P.M. Entered hospital, 4 P.M.

Mrs. F., German, age sixty-seven, married 38 years, two children. States that five or six months ago was conscious of slight pain in the left side, particularly upon exertion; also noticed a more frequent desire to urinate. Other than the frequent urination and slight pain in left hypochondriac region, previous personal and family history negative. During the past two months, the frequency of urination has been more troublesome. Always constipated. Ceased menstruating at 47.

Examination.—Well nourished, very anæmic, skin bronze-like hue, conjunctiva jaundiced, facial expression anxious. Tongue thickly coated and dry. Heart and lungs normal. No enlargement of the lymphatics.

Abdomen: Prominence of the left side, extending from free border of ribs to pelvis. Palpation showed a more or less irregular mass, rather boggy in this area. Dulness extended from near the centre of the abdomen to the posterior axillary line. Pain on pressure was most pronounced over the region of the left kidney. Pelvis negative. Temperature 99°; pulse 102; respiration 36.

During the next 24 hours there was an almost constant desire to urinate, patient passing 22 ounces of urine in this time. Urine showed albumin, pus, and casts.

Feb. 10 to 12: Temperature ranged from 99° to 101°, less pain in abdomen, but prominence more pronounced. Amount of urine for 24 hours did not exceed 26 ounces. Urine continued to show blood and pus.

Feb. 14: Cystoscopic examination showed evidence of chronic cystitis. Ureteral catheter introduced into the left ureter and left *in situ* six hours. Diagnosis of pus kidney made, and operation advised, but refused by family.

Feb. 14 and 18: Patient's condition seemed to improve, began to take light food, and bowels moved daily. Less abdominal pain, and diminution of abdominal distention. The mass diminished in size, extending to within two inches of the umbilicus and to within three inches of iliac crest. Extremely tender over entire left side. Rigidity of right rectus. There continued to be frequent desire to urinate, which seemed to be relieved when patient was placed in semireclining position. The low 24 hours' urine persisted, varying from 18 to 24 ounces; each examination showing blood and pus.

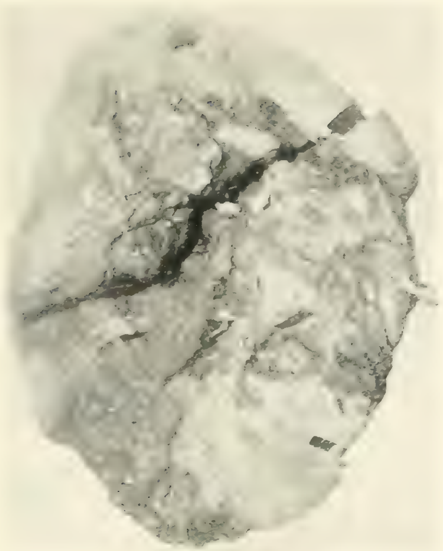
On the morning of Feb. 19, patient had a severe chill, lasting 15 minutes, followed by a rise of temperature to 102.4°, pulse 128. Tumor in left side more prominent and distention more pronounced. Pain excruciating.

Operation at 1 P.M., Feb. 19. Longitudinal incision in lumbar region from ribs to ilium. When kidney was reached, it was found about one-third larger than normal, surface apparently normal. Large intraperitoneal hæmatoma presented. Peritoneum opened, when there was evacuated three or four quarts of chocolate-colored blood and clots. When cavity was cleansed, there presented an enlarged spleen having several lacerations of its capsule, upon its upper surface. An incision extending inward from the upper extremity of the original cut was made, giving freer access to the spleen. Spleen was then turned over. Splenic vessels clamped and ligated and spleen removed. Patient's condition was serious; 1200 c.c. normal salt solution given intravenously.

Two days after the operation, the temperature was 99°; pulse 86. From this time convalescence was uneventful, the patient leaving the hospital on the thirty-fifth day after operation. The maximum temperature during convalescence was 99.4° and maximum pulse 98. The maximum amount of urine passed in any 24 hours during this period was 41 ounces.

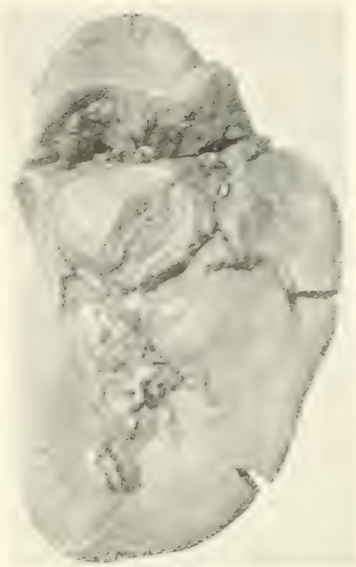
The patient remained in fairly good health for 11 months after leaving the hospital, when she died, from what the attending physician designated as pneumonia. It would seem fair to pre-

Fig. 1.



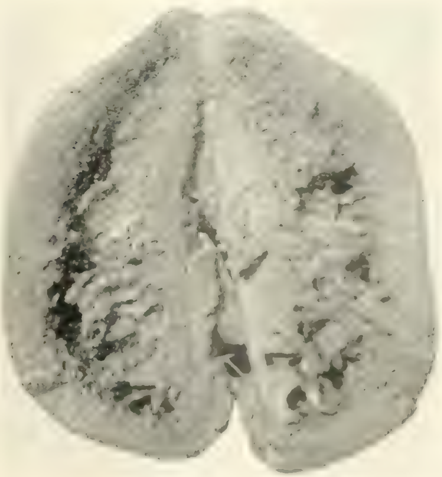
Contusion of apparently normal spleen; subsequent rupture (Case II).

Fig. 2.



Contusion of malarial spleen; intracapsular hemorrhage; rupture (Case III).

Fig. 3



[illegible] rupture (Case IV).

sume that the cause of death was probably pulmonary tuberculosis. It is also probable that the lesion in the left kidney was tubercular. The peritoneum and intestines exposed appeared normal.

The pathological report of the spleen, signed by Dr. F. R. Sandt, is as follows:

> *Specimen of a Spleen.*—Case of Mrs. F. The organ measured 25 cm. in length and 16.5 cm. in width. Weight 450 Gms. The specimen was uniformly enlarged and the surface smooth. To the touch there was a doughy feeling as if a cystic condition existed. The capsule was thin and stripped easily; three ruptures of the capsule through which the splenic pulp protruded were noted. A longitudinal section of the organ showed a firm periphery, but the central portion was partially destroyed and converted into a number of small irregular communicating cavities, the walls of which were composed of the fibrous tissue of the spleen or the trabecula. Microscopic sections from the periphery gave the picture of an acute splenitis. The capsule was thin, no trabecula and Malpighian corpuscles were visible. The cells were closely packed together, and four types of cellular elements were found. First, the cells of the splenic pulp, large granular elements similar to the large mononuclear cells of the blood; second, small lymphocytes; third, narrow sickle-shaped cells; and fourth, polymorphonuclear leucocytes. A fatty degeneration of some of these cellular elements was noted. Sections from the deeper portions show a number of imperfectly formed and degenerating tubercles. Numerous giant-cells were noted. These tubercular processes were surrounded by densely packed lymphocytes. Tubercle bacilli were demonstrated in these areas, within the giant-cells, and from the broken-down material from the interior of the cavities.
>
> *Diagnosis.*—Acute hyperplastic splenitis secondary to a chronic tuberculous splenitis.

The third case demonstrates the effect of trauma upon an apparently normal spleen, the injury resulting in a contusion of the organ, causing a laceration of the splenic pulp, and producing an intracapsular hemorrhage. The tension upon the capsule becoming more and more intense, finally terminated in a rupture of the organ four days after the reception of the injury.

CASE III.—*Intracapsular contusion of spleen, followed by rupture of organ.* A male, fifteen years old, an American, was admitted to my service with the following history: Three days before admittance to hospital, while coasting down a hill of moderate grade, in attempting to avoid a bob sleigh, left side of abdomen was struck by fore runner of sleigh. He was able to arise, walked one-half mile to his home, complaining only of a slight pain in left side of chest and abdomen. This pain, however, gradually became more intense, becoming localized to left superior quadrant of abdomen, and was constant. On account of the increasing severity of the pain, twelve hours after the accident a physician was summoned, who treated the case palliatively for three days, during which period the patient was slightly prostrated and presented only one symptom, that of pain. Urination was normal. There were no gastro-intestinal disturbances.

Physical examination showed a young, fairly well-developed man, markedly anæmic, prostrated, restless, respirations thoracic. Head, neck and chest were normal. The abdomen was uniformly distended; abdominal respiration was absent. There was rigidity of both recti, most marked on left side. Tenderness was present over entire epigastrium. Dulness existed on left side, extending anteriorly to within one inch of anterior axillary line and extending upward to seventh intercostal space. On the right side of abdomen, dulness reached anterior axillary line. Dulness did not shift.

Temperature was 102°; pulse 98, regular fair volume; respirations were 22. About 18 hours after entering the hospital, pulse suddenly rose to 132, became irregular, small, and tension was below normal. Respirations rose to 28, and temperature fell to 101°. Patient became restless, jumped out of bed, abdomen became suddenly distended, and patient went into a condition of partial collapse.

On account of history of injury, of syndrome of symptoms presented, with localization of pain in left superior quadrant of abdomen, a diagnosis of ruptured spleen was made. In view of the fact that the patient had passed only 11 ounces of urine in the past 18 hours, the possibility of rupture of the kidney was also considered, although there were no pathological urinary findings.

Four hours after condition of partial collapse had come on, patient was operated upon. A median incision 10 inches long was made over middle abdomen. Abdominal cavity contained large amount of dark blood. The upper angle of incision was prolonged laterally under free border of ribs. Spleen was found lacerated and about twice normal size. In order to control hemorrhage, it was found necessary to extirpate the organ.

Patient, beyond suffering from shock subsequent to operation, made an uneventful recovery and was discharged four weeks after operation. June 9, 1911, examination showed him to be in perfect physical condition; has gained 24 pounds in weight since the accident. During past spring has entered several canoeing contests in long-distance races.

PATHOLOGICAL AND BLOOD REPORT BY DR. F. R. SANDT.

Specimen of Spleen.—J. W. The specimen measured 16.25 cm. in length, 11.25 cm. in width, and weighed 392 Gm. The organ was slightly enlarged, surface smooth, firm to the touch, capsule normal, edges sharp. A ragged tear extended over the anterior surface of the spleen, involving the capsule and splenic tissue to about the centre of the organ.

Microscopical Examination.—No pathological changes were found in the tissue except in the area about the traumatism, where there was an extensive hemorrhagic infiltration.

Diagnosis.—Rupture of the spleen and traumatic hemorrhagic splenitis.

Blood Examinations.—On admission to the hospital on Feb. 4, 1910, an examination of the blood showed the following condition: red cells 3,408,000; leucocytes 19,000; hæmoglobin 70 per cent.

Differential count: small lymphocytes, 10 per cent.; large lymphocytes, 15 per cent.; polymorphonuclear forms, 74 per cent.; eosinophiles, 1 per cent.

After operation on Feb. 5, 1910, the count was as follows: red cells, 2,472,000; leucocytes, 15,600; hæmoglobin, 30 per cent. Differential count had not materially changed: small lymphocytes, 16 per cent.; large lymphocytes, 12 per cent.; polymorphonuclear cells, 69 per cent.

On Feb. 8, 1910, three days after operation, the maximum changes were found. At this time the red cells reached their lowest point, 2,300,000; the leucocytes attained their highest point, 30,800, and the hæmoglobin was present only to the extent of 20 per cent. Differential count: small lymphocytes, 16 per cent.; large lymphocytes, 9 per cent.; polymorphonuclear forms, 75 per cent.

A gradual improvement in the blood state now ensued; the red count gradually increased, the leucocyte count fell to the neighborhood of 18,000, and the quantity of hæmoglobin slowly increased. One month after operation a count gave 4,320,000 red cells, 19,500 leucocytes, and 85 per cent. of hæmoglobin. The differential count gave 26 per cent. of small lymphocytes; 18 per cent. of large lymphocytes; 54 per cent. of polymorphonuclears, and 1 per cent. of eosinophiles.

Three months after operation, on April 15, 1910, the count was as follows: red cells, 4,600,000; leucocytes, 17,200; hæmoglobin, 85 per cent. Of the leucocytes, 20 per cent. were of the small lymphocytic variety, 6 per cent. were of the large forms, 3 per cent. were of the transitional varieties, 62 per cent. were polymorphonuclear, and 9 per cent. were eosinophilic. This count gave us the maximum number of eosinophiles

On March 9, 1911, 13 months after operation, a count gave 4,720,000 red cells, 16,200 leucocytes, and 90 per cent. of hæmoglobin; 18 per cent. of the leucocytes were of the small lymphatic variety; 10 per cent., large lymphocytes; 3 per cent., transitional; 67 per cent., polymorphonuclears, and 2 per cent. eosinophiles.

On June 9, 1911, the results were as follows: red cells 5,560,000, leucocytes 15,800, and hæmoglobin more than 100 per cent. The differential count gave 16 per cent. small lymphocytes; 11 per cent. large lymphocytes; 9 per cent. transitional forms; 63 per cent. polymorphonuclears, and 1 per cent. eosinophiles.

Conclusions.—No permanent blood changes were found in this case. Sixteen months after operation a normal condition with a slight increase in the number of leucocytes was found. The leucocytes in this case seem to persist at a slightly higher level than normal. The hæmoglobin was restored more quickly, and the normal color index was found sooner than in a case to be subsequently reported.

The eosinophilia, which has been noted by other observers as following splenectomy, was only moderate in this case and developed two months after operation. No structural changes in the red cells were ever noted in any of the specimens examined.

The fourth case demonstrated the effect of traumatism upon a pathological spleen, which was probably enlarged as the result of a chronic malarial infection, the traumatism causing a contusion and laceration of the splenic pulp and the accompanying intracapsular hemorrhage. The rupture occurred 48 hours after the injury. It is of interest to note the recurrence of a malarial infection following the injury to the spleen, and the fact that, although a short course of malarial treatment was instituted at this time, there has been no recurrence of the malarial trouble since the attack occurring 10 days after the splenectomy, nor have the malarial organisms been found at any time during the past four months.

Case IV.—Male, Holland, age twenty years, painter, while working on a roof fell from a height of 40 feet, striking left side on ground. Patient was unable to arise, was semiconscious; complained of pain in left shoulder. He was immediately taken to hospital, November 9, 1910.

Past History.—Patient has had frequent attacks of malaria, last attack being six months prior to accident. Was treated for chills and fever for two months.

Physical Examination.—With exception of slight abrasion about one inch long on forehead, head was normal. Neck and chest normal. The left shoulder drops forward, downward, inward. There is a diffuse swelling over anterior end of clavicle, over which tenderness and crepitus can be elicited. Abdomen shows only slight rigidity of left rectus, most marked lower portion where patient complains of pain on pressure. Spleen not palpable. Liver normal. No masses, no fluid made out. Pulse 110; respiration 24; temperature 99.6°. General condition was fair. Patient vomited a few times; vomitus, food and bile. About 18 hours after admission, patient went into a condition of collapse. The pulse became small, rapid, 136; tension low; respiration 24; temperature 100.8°. Abdomen slightly distended, absolutely rigid, tenderness diffuse over entirety. On account of marked rigidity and tenderness definite signs were not obtainable. Rectal examination showed mass in pelvis, which was soft and fluctuated. A Leiter coil was applied over abdomen and Murphy drip given.

About 48 hours after admission patient went into a condition of collapse; pulse became very rapid and irregular, respirations were shallow, thoracic, had a peritonitic facies and appeared markedly anæmic. Abdomen appeared board-like.

On account of history of injury, of anæmia present, together with set of symptoms presented, a diagnosis of rupture of the spleen was made. Urination being normal and there being no pathological urinary findings, rupture of kidney was not considered.

Four hours after the symptom complex had become aggravated or 52 hours after reception of injury, patient was operated upon. Incision about five inches long made along border of left rectus in upper two-thirds of abdominal wall. A large amount of chocolate-colored blood was found in peritoneal cavity. Incision was prolonged from upper angle of wound along free border of ribs and downward from lower, for distance of three inches.

Spleen was found lacerated and about four times normal size. In order to remove organ, it was found necessary to incise costal cartilage of tenth rib near chondrocostal junction. After ligation of vessels, abdomen was flushed out with warm normal saline. A stab wound was made in flank and cigarette drain inserted. After recovery from shock of operation, patient made rapid recovery, although 15 days after operation he had a chill, rise of temperature to 103°, pulse 128, followed by profuse sweating.

Two days later, temperature rose to 103.4°, pulse 130, preceded by chill and followed by sweating. This yielded to quinine. Plasmodia found in blood. Forty-two days after admission, patient was discharged, cured.

From this time convalescence was uninterrupted. Plasmodia were found in blood 15 days after admission. Have not been found since that time, although there have been frequent examinations of the blood, the last examination made June 10, 1911.

PATHOLOGICAL REPORT AND BLOOD FINDINGS BY DR. F. R. SANDT.

Specimen of Spleen.—S. D. The specimen measured 20 cm. in length, 1.25 cm. in width, and weighed 375 Gms. The organ was somewhat enlarged, edges rounded, surface wrinkled, capsule thickened, and adherent. A laceration was noted extending over the middle of the spleen, dividing the organ for about two-thirds of its extent. The microscopical sections show a thickened capsule, prominent trabecula, and prominent Malpighian corpuscles. The splenic pulp was not distinct, and in sections stained with iodine very small mahogany-brown areas were found. The central artery of the corpuscle was normal, but the finer vessels leading from it through the corpuscle show waxy changes. Sections from the area near the traumatism show hemorrhagic infiltration.

Diagnosis.—Rupture of the spleen; beginning amyloid degeneration of the spleen, which is probably a secondary result of a malarial condition.

Blood Examinations.—A blood count made after admission to the hospital on November 10, 1910, resulted as follows: red cells, 4.000,000; leucocytes, 17,000; hæmoglobin, 70 per cent.; the differential count being normal, showing 20 per cent. of small lymphocytes; 4 per cent. of the large mononuclears; 5 per cent. of transition forms; 68 per cent. polymorphonuclears and 2 per cent. eosinophiles.

On the morning of November 12, 1910, before operation, the red cells were found to number 3,136,000, leucocytes, 37,000, and the hæmoglobin had dropped to 40 per cent.

On the evening of November 12, 1910, after operation, there was a further reduction in the red cells to 2,406,000; the leucocytes numbered 25,000, and the hæmoglobin was reduced to 35 per cent., which was the lowest point reached in this case. The number of red cells were also lower at this time than at any subsequent time. On this date there was a marked change in the differential count, the average number of cells, as based on the two counts, giving 4 per cent. lymphocytes; 3 per cent. large mononuclears; 0.5 per cent. transition forms; 92.0 per cent. polymorphonuclears, and 0.5 per cent. of eosinophiles.

On November 13, 1910, the red cells were found to number 3,000,000; the leucocytes, 37,600; and 40 per cent. of hæmoglobin; 87 per cent. of the leucocytes being polymorphonuclear.

No material changes were found in the blood examinations, with the exception of the increase of the hæmoglobin to 50 per cent. until November 23, 1910, when the red cells dropped to 2,736,000 and the highest leucocytosis of the series, 39,600, was recorded; at this time the polymorphonuclear cells were present to the extent of 88 per cent. Nothing unusual was noted on this date, when the stained preparations were examined for the differential count, and the rise in temperature, when associated with a leucocytosis of 38,600, was attributed to a possible infection.

The periodicity and the degrees of temperature elevation on November 24, with no local evidence of suppuration, led to another examination of stained preparations, and at this time tertian malarial parasites were easily detected. They were so numerous that from four to five organisms could be found in a single microscopic field.

On November 28, 1910, after a daily administration of quinine, the red cells were found to number 3,040,000; the leucocytes, 9,200; and the hæmoglobin remained stationary at 50 per cent. At the time of this examination, the differential count showed 39 per cent. of small lymphocytes; 23 per cent. large lymphocytes; 2 per cent. transition forms; 32 per cent. polymorphonuclears and 4 per cent. eosinophiles.

From this date on until January 16, 1911, there was not much change in the blood findings, except that the red cells were gradually increased in number and the percentage of the various forms of leucocytes again became normal. The hæmoglobin did not vary, but remained constant at 50 per cent.

On January 16, 1911, the red cells had increased to 5,024,000; the leucocytes numbered 17,000; and the hæmoglobin registered 65 per cent. The differential count at this time resulted as follows: small lymphocytes, 14 per cent.; large mononuclear forms, 15 per cent.; transition forms, 5 per cent.: polymorphonuclear forms, 55 per cent.; eosinophiles, 8 per cent.; myelocytes, eosinophilic in character, 3 per cent.

The increase in the number of eosinophilic cells reached their maximum on March 6, 1911, when 14 per cent. of the leucocytes were of this form. On this date, the red cells were practically normal at 4,800,000; the leucocytes, 5,880; hæmoglobin, 70 per cent.; polymorphonuclear forms, 45 per cent.; and 17 per cent. small lymphocytes.

Subsequent counts in the case gave no additional points of interest The final count in the case was made on June 6, 1911. The results were as follows: red cells, 5,456,000; leucocytes, 11,600; hæmoglobin, 90 per cent.; the differential count showed 15 per cent. small lymphocytes; 6 per cent. large mononuclears; 7 per cent. transition forms; 70 per cent. polymorphonuclears, and 2 per cent eosinophiles

The points of interest in the blood findings in this case were: 1. The absence of any marked reduction in the red cells following the operation, other than that caused by the hemorrhage resulting from the traumatism and the effects of the dilution of the blood by the saline transfusion, and the absence of any of the abnormal forms of red cells; poikilocytes, nucleated red cells, and abnormally large or small cells were not noted at any time.

2. The slow regeneration of the hæmoglobin; a low color index was noted at all examinations up to the date of the last one, when it was found to be 0.99. For three months following operation, the hæmoglobin remained constant at 50 per cent., even though the number of red cells had gradually increased to practically normal.

3. The occurrence of a moderately severe leucocytosis immediately following the hemorrhage for which operation was performed, which reached its maximum ten days after operation (39,600) and which then rapidly declined to practically normal within another week.

4. The gradual development of a moderate eosinophilia, which reached its maximum about four months after operation and which then fell to the normal limit.

5. The appearance in the blood of an active malarial process ten days after operation, at a season when there was no possibility of a fresh infection by the Anopheles. With the history of an active malaria during the preceding summer, can this be explained on the basis that the parasites were dormant in the spleen and were liberated into the general circulation at the time of the traumatism and hemorrhage?

6. The absolute restoration of the blood in quality, as evidenced by the normal count obtained seven months after the removal of the spleen.

In neither of the two cases which have been carefully watched since operation has there been changes in lymph-glands, enlargement of the thyroid, or pains in the long bones.

The diagnosis of contusion of the spleen causing an enlargement of the organ from intra-capsular hemorrhage can only be made upon the previous history of trauma. There is no symptom characteristic of the condition, nor would it be possible to differentiate from a tumor of the spleen due to other pathological changes, which might have been present prior to the injury. A patient showing a tumor and evidencing pain: the splenic area following trauma in this region, particularly if accompanied by abdominal rigidity, should be carefully observed for subsequent rupture of the spleen. The diagnosis of rupture of the spleen is difficult, whether the rupture occurred at the time of injury, or the traumatism was the result of the contusion and subsequent rupture.

When rupture has occurred, the clinical picture does not differ materially from intra-abdominal hemorrhage due to rupture of other organs. It is not always possible to differentiate between rupture of the spleen and rupture of the kidney. The pressure resulting from the accumulation of blood from a ruptured spleen may cause urinary symptoms closely resembling those found in rupture of the kidney. In rupture of the kidney, we have found in several cases that on careful rectal examination there could be distinctly felt an elevation of the posterior parietal peritoneum of the left side, due to hæmatoma from the ruptured kidney, which symptom is absent in splenic hemorrhage.

I am indebted to Dr. F. R. Sandt for the careful blood observations made in these cases.

PROLAPSED SPLEEN WITH ACUTE TORSION; SPLENOPEXY.

WITH TABLE OF UNREPORTED CASES TO DATE.

BY FRANK H. LAHEY, M.D.,

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Case Report.—Mrs. W., housewife, seen in consultation with Drs. E. N. Libby and J. P. McCue. Three months ago was in hospital with an attack similar to present, but much less severe. Several slight attacks since. Patient would not go out, fearing pain would come on while away from home. No history of malaria. Four days ago patient was taken with a sharp pain in left hypochondrium, cramp-like in character, and so severe that it caused her to vomit. Pain and vomiting have persisted, with only short intervals of relief. Between attacks there is no desire to vomit. The pain is said to be much worse when lying on her right side, better when on back, and better still when holding on to lower abdomen, but touching her upper abdomen is impossible on account of "sore place" just to left and above umbilicus. She states that the pain is never in front, but always in the left side, beneath ribs. The pain is in no way referable to food, and is not relieved by vomiting. There has been no blood in the vomitus or urine. The bowels have moved well at all times, and there has been no passage of urine in relation to the attacks.

The patient is a well-developed and nourished woman. Heart, lungs, and general examination negative, except for the abdominal findings. Just below rib in left hypochondrium there is considerable tenderness, but practically no spasm of the rectus can be made out. On deep palpation a smooth, round mass may be felt, which is movable downward as far as the umbilicus and displaces easily on pressure outward toward the loin. It is acutely tender, and any degree of pressure causes the patient intense pain. On account of this tenderness it is not possible to palpate the tumor bimanually in the loin. It is apparently solid in consistency.

The white count is 8400; temperature has never been above 100°; and the urine is negative.

A diagnosis of prolapsed spleen or kidney was made, with a feeling from the ease with which it displaced toward the loin that it was a loose and twisted kidney.

Operation was advised and accepted. A lumbar incision was made and the kidney pulled into the wound. It was found only slightly movable and it was evident that it was not the tumor felt in the abdomen, as with the hand in the kidney pouch it was possible to still feel the smooth tumor through the unopened peritoneum. The kidney capsule was split and a few stitches inserted to hold it in place. The loin wound was closed and the patient turned upon her back. The abdomen was then opened through the left rectus muscle, just below the costal margin, and a large slaty-red mass dotted with flakes of fibrin brought up into the wound by the examining hand. It was evident at once that the mass was an enormously enlarged spleen, and on closer examination it was found that the broad pedicle of parietal peritoneum was so twisted on itself as to almost completely shut off its venous return. Upon the surface of the spleen were numerous fine flakes of fibrin and at one pole a small accessory spleen. On examination it was evident that the spleen was still quite closely attached to the abdominal wall at its inner pole, and that it had practically rotated upon this attachment.

The liver, kidneys, stomach, and transverse colon seemed in normal position, and were not prolapsed.

The spleen was untwisted, returned to its normal position, and fixed there by four large stitches of chromic catgut, passed through the loose peritoneum close to the spleen, which formed the pedicle, and then with the intestines well packed off, into the tissue covering the parieties, endeavoring in each case to include periosteum in the grasp of the needle. These stitches were tied, the accessory spleen removed for pathological examination, and the abdomen sutured in layers.

On coming out of ether, the patient no longer complained of pain, nor has she at any time since—now four and a half months after operation. Her recovery was uneventful, the wounds healing by first intention. She was not allowed to leave the reclining position for approximately one month. Since that time she has been about her affairs with no return of symptoms in the slightest degree.

The pathological report of sections taken from the accessory spleen was normal spleen tissue, except for enormous congestion.

An examination of the abdomen at this time, four and a half months after operation, finds the spleen just palpable below the costal border, and not movable to any extent from side to side.

Etiology.—Prolapse of the spleen occurs as a part of general enteroptosis, or may be caused by congenital anomalies, such as abnormal length of the ligaments or by acquired lengthening, the result either of trauma or increased weight of the spleen, due to malaria, leukæmia, or pseudoleukæmia. As a proof of the congenital origin of the relaxation of the splenic ligaments, Osler cites its occurrence in different members of the same family.

It is an interesting fact that, although prolapse of the spleen occurs commonly with general enteroptosis, in a majority of the cases operated upon and reported, nothing is said of ptosis of the other organs, and in this case, as is stated in the history, the abdominal organs were in apparently normal position.

Diagnosis.—The diagnosis of prolapsed spleen is made from the shape and position of the organ, and may be confirmed by palpation of its edges and by the most confirmatory sign of all, the feeling of the splenic notches. In certain instances it is said that the vessels entering the spleen may be palpated. The diagnosis is also aided by ruling out kidney prolapse after ascertaining that both kidneys are in normal position. In most cases where the diagnosis has been made, the splenic notches have been felt.

Symptoms.—In all cases of torsion there is great pain, due to dragging on the pedicle from the additional weight of the congested spleen, stretching of the capsule from the same cause, and the occurrence of an acutely tender mass, as a rule movable in all directions unless surrounded by adhesions. Temperature, pulse, vomiting, and shock are dependent upon the degree of torsion.

Treatment.—The indications are to remove the twist and to restore the organ to as near normal conditions as possible with a reasonable prospect of its remaining so, and if this is not possible, to remove it. In the list of cases reported since June, 1908, only one is spoken of in which splenopexy was done, and in this case gauze packing was also used. In another the spleen was simply untwisted and no attempt made to restore it to place; and in another, gauze packs and a belt were used. In the remaining cases splenectomy was practised. There were no fatal results in any of the methods of treatment.

In nearly all of the treatises on surgery, splenectomy is recommended and splenopexy condemned because of the proneness, it is stated, of the prolapse to recur in cases with a marked degree of descent. That this is true seems more than likely, yet in view of the lessened danger, the somewhat hazy idea which we still have about the spleen, and the success of the simple procedure in these three cases and in other cases reported in the earlier literature, it seems that there must be a place for splenopexy, either by suture, packing, or pouch. In a certain group of cases similar, I believe, to the case here described, in which all of the supporting structures of the spleen are not yet gone and the spleen has not prolapsed into the lower abdomen, also in those cases in which time is of the greatest value on account of previous shock or exhaustion from pulling on the splenic pedicle or the suffering which goes with it, untwisting the pedicle and suturing into as near normal position as possible, with packing or not, will be the most rational treatment, and the place most suitable for splenopexy.

In those cases where the spleen is in the pelvis, or low down in the abdomen, with a long and corded pedicle making splenectomy rapid and simple, it will be the operation of choice, with only slight danger and an absolute guarantee of nonrecurrence.

In this case to have removed the spleen would have been a much different problem than the simple removal of a spleen with a long pedicle, and would have added a degree of risk that would have been unjustifiable.

In an article on splenectomy, George Ben Johnson reports the occurrence, prior to 1890, of splenectomy for torsion five times, with four deaths; between 1890 and 1900, eleven times, with four deaths; and between 1900 and 1908, eleven times, without a death.

Below is submitted the cases of prolapsed spleen with torsion reported in the literature since that date (June, 1908); six treated by splenectomy without a death; one by simple untwisting resulting in recovery; one by untwisting and packing; two, including the author's, by splenopexy, resulting in recovery.

C. R. Blackburn and R. G. Craig. Australian Med. Gaz., Dec., 1907, vol. xxvi, p. 615. Replaced from pelvis and held by pads. Good recovery.

Asa B. Davis. Bull. of the Lying-In Hosp. of N. Y. City, vol. v, No. 1, p. 24, June, 1908. Splenectomy while pregnant. Recovery and normal delivery.

J. E. Gemmell. Jour. of Obstetrics and Gyn. of British Empire, London, Oct., 1908. Untwisted and not removed on account of patient's condition. Seen a year later without symptoms.

J. E. Gemmell. Jour. of Obstetrics and Gyn. of British Empire, London, Oct., 1908. Splenectomy. Recovery.

Adam Reuterskiöld and Artur Vestberg. Upsala Läkareförenings Förhandlingar, June 20, xiii, No. 5, p. 355. Splenectomy. Recovery.

P. Paterson. London Lancet, No. 20, 1909. Splenectomy. Recovery.

I. MacDonald and W. A. Mackay. London Lancet, Sept. 25, 1909. Splenectomy. Recovery.

W. J. Mayo. Jour. A. M. A., vol. liv, No. 1, p. 14. Suture and packing. Recovery.

CYSTS OF THE OMENTUM.*

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Cysts of the omentum are uncommon; they give two main varieties of interest: (1) practical, referring to their diagnosis and treatment; (2) academic, referring to their origin.

1. From the practical stand-point we may remember that at rare intervals these cysts are found, that their symptoms in non-malignant cases are mainly mechanical, due to pressure or traction on surrounding structures, and that operations have in the main been successful and free from serious difficulty, about 86 per cent. of the reported cases having ended in recovery.

2. Origin: The origin in most of the cases has been apparently similar to that of mesenteric cysts. In a discussion of mesenteric cysts held before this society several years ago, the members assented to their classification into: (1) embryonic cysts; (2) cystic malignant disease; (3) echinococcus cysts.

Most of the cysts of the omentum may be included in the same classification, for it is evident that embryonic rests may occur between the peritoneal layers of the omentum as they do between those of the mesentery, although such occurrence is less common.

Cystic malignant disease and echinococcus cysts are occasionally found in the omentum, but their consideration does not properly come within the limits of this paper.

A number of very able articles have been written on omental cysts, among which we may particularly mention that by Hasbrouck.[1] By its aid and with a pains-taking search of the literature, Doctor Farr has prepared the following table.

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* Read before the New York Surgical Society, March 22, 1911.

TABULATED DESCRIPTION OF OMENTAL CYSTS, EXCLUDING ECHINO-

Number	Age	Sex	Result	Symptoms	Cyst Wall						Lining			Contents				
					Thick	Thin	Unilocular	Multilocular	Closed sac	Fluid in folds of omentum	Endothelium	Epithelium	Fibrous	Clear or light colored fluid	Dark colored fluid	Coagulated blood	Milky	Pus
1	Adult	F.	D.	Not given.					+ large					+				
2	44	M.	D.	Anuria(?).		+ 1mm		+					+			+		
3	58	F.	C.	Like ovarian cyst											+			
4	19	F.	C.	Pain at menses. Vomiting Shooting pain			+ ?		+					+				
5	4	F.	C.	Ailing gen'ly.		+	+							+				
6	48	M.	C.					+					+		+			
7	22	F.	C.	No pain. Sudden growth.		+	+				o		+	+				
8	2½	F.	C.	Emaciation				+							+			
9	Adult	F.	C.															
10	8	M.	C.	Dyspnœa Frequency.				+							+			
11	4	F.	C.	None		+	+							+				
12	7	F.	C.	Emaciation.		+		+			+			+				
13	1 yr 8 mo.	F.	C.	Pain Diarrhœa.		+		+					+		+			
14	21	M.	D.	General condition bad.	+											+		
15	1	F.	C.	Anorexia. Vomiting. Constipation.		+		+						+ Rose				
16	11	M.	C.	Vomiting. Pain. Anorexia. Emaciation		+	+ ?								+			
17	9½	F.	C.	Emaciation.		+		+							+			
18	2½	F.	C.	Indigestion.						+					+			
19	17	F.	C.	None but pressure.			+						+	+				
20	6	M.	C?	Pain.				+						+				
21	19	F.	C.	Pain Tenderness.		+ 3mm.	+ ?						+		+	+		
22	4	M.	C.	Emaciation.		+	+			+			+		+	+		
23	15	F.	C.								+		+		+			
24	51	F.	C.			+		+			+		+		+			
25	51	M.	C.	Vomiting. Emaciation.		+ 2–4 mm							+		+			
26	4½	F.	C.	Gastro-enteritis.		+		+			+		+	+				
27	Child	M.	C.			+ 3-5 mm	+						+		+			
28	50	F.	C.			+		+			+			+				
29	4	M.	?	None.		+		+				+	+	+				
30	38	F.	D.			+		+			+ ?			+				
31	50	M.	D.			+		+				+		+				
32	8	F.	C.	Pain. Vomiting.	⅛"		+											+
33	26	F.	C.					+										
34	37	F.	C.	None.			+								+			
35	43	F.	C.	Pain Vomiting. Dyspnœa.	+ 7 mm		+						+		+			
36	8	M.	C.	Vague pain. Dyspnœa.			+ ?						+		+			
37	62	M.	C.	Emaciation Weakness.	+										+			

COCCUS CYSTS AND CYSTIC MALIGNANT DISEASES. By Chas. E. Farr, M.D.

Remarks	References
Autopsy specimen	Gairdner, W. T.: Trans. Path. Soc., London (1850–51), 1852, iii, 374.
Present 12 years. Autopsy specimen	Simon, E.: Bull. Soc. Anat. d. Paris, 1858, xxxiii, 30.
Many years	Doran, Alban: Trans. Obst. Soc., London, 1882, xxiii, 164.
Followed blow. Present 1 year	Gooding, J. C.: Lancet, London, 1887, i, 311.
Contained 4 pints	Wells, Spencer: Brit. Med. Jour., 1890, i, 1362.
No trauma. [Small cell sarcoma in wall.] Gradual development	Cazin, M.: Bull. Soc. Anat. d. Paris, 1893, lxviii, 312.
Vascular inner wall. Contained 9 litres (partly necrotic material)	Erdheim, S.: Wien. klin. Rundschau, 1896, x, 131.
Large hemorrhagic	Marfin, A. B.: Press. Med., Paris, 1896, 133.
Albuminous fluid and cholesterin	Jessett, F. B.: Brit. Gynæc. Journ., 1896–7, xii, 156.
Abdomen measured 44 in. Omental cyst diagnosed	Hearn, W. J.: ANNALS OF SURGERY, 1897, xxv, i, 703.
Iridescent patches; 3½ pints	Braithwaite, J.: Lancet, London, 1898, ii, 1472.
	Jacobi, A.: Trans. Assoc. Am. Phys., 1901, xvi, 232.
Ten pints	Marsh and Monsarratt: Brit. Med. Journ., London, 1901, i, 511.
Blow on stomach 3 mos. before. Communicated to stomach	Catman, H. H.: Brit. Med. Journ., London, 1902, i, 1267.
Few red blood-cells	Schramm, H.: Zentralb. f. Chir., 1903, xxx, 564.
Had a lining membrane. Attached to pancreas; 12 pints	Boyd, S.: Clin. Journ., London, 1903, xxi, 306.
32 pints	Young, W. McG.: Lancet, London, 1905, i, 157.
Bloody fluid	Fort, R. E.: ANNALS OF SURGERY, 1907, xlv, iii, 382.
60 lbs.	Rodman, J. S.: ANNALS OF SURGERY, 1909, xlix, 427.
Smooth lining membrane	Gifford, A. H.: Brit. Med. Journ., London, 1910, i, 1289.
	Holleman: Zentralblatt f. Gynäk., 1908, xxxii, 297.
Unaltered blood; short duration; 2½ litres	Seefisch, G.: Deutsche med. Wchenschr., Leipsig, 1909, xxxv, 1790.
"Lymphangiectasis"	Brandt: Zentralbl. f. Gynäk., 1894, p. 991.
Bloody fluid	Wagener: Nederl. Tijdschrift v. Geneeck., 1902, dl. 2.
Reddish jelly-like, partly calcified wall	Ris: Bruns Beiträge z. klin. Chir., x, 1893, 423.
By Czerny	Schwarzenberger, B.: Bruns Beiträge z. klin. Chir., Tubing., 1894, xi, 713.
Chocolate colored fluid. Clinic of Prof. Signori	Costa, Tomasso: Giornale internaz. del Scienze, Med., 1908, xxx, 357.
Died later—autopsy	Himmelheber, K.: Archiv. f. Gynäk., 1909, lxxxviii, 62.
Noticed 2 years	Wakefield, W. F. B.: Trans. Am. Gyn. Ass'n, [illegible], xxxii, 417.
Some ciliated cells in lining. Autopsy case (pyæmia)	Karás, Henrietta: Virchow's Archiv., Bd. clxxxviii, 138.
Autopsy specimen. Contents homogeneous	Henke: Verhandl. d. deutsche path. Gesell., Bd. ii.
Suppurating dermoid; 3 plates of bone; pus	Waldy, J.: Lancet, 1889, vol. ii, 642.
Present 6 years; much ascites, 75 lbs.; fluid too thick to run	Ormsby: Med. Press and Circular, London, 188[illegible], vol. xxx[illegible], [illegible]8.
No trauma, wall partly gangrenous	Edebohls: New York Journ. Obst. and Gyn., 1893, vol. iii, 514.
Few blood-cells; no epi- or endothelium; lesser omentum	Schwartz, Rodolfo: Gazet. degli Ospedali, 1902, vol. xxiii, 784.
No trauma; few blood-cells, lymphangioma	Mathews, Paul: Brit. Med. Journ., 1905, vol. ii, 171.
Cystic tumor	Bidwell, Leonard J.: Brit. Med. Journ., 1905, vol. ii, 806.

It will be seen that most of the cases have been very incompletely reported, and that there have been few exhaustive descriptions of the cyst walls and the cyst fluid, hence it is impossible to reason with accuracy as to their origin. Apparently most and possibly all of these cysts were of embryonic origin. One must, however, notice how large a proportion of them gave evidences of blood in their contents—four of them contained coagulated blood, eighteen contained fluid so dark in color that they had apparently contained blood.

It is self-evident that an ordinary hæmatoma in the omentum should not be described as a cyst, but the results of hemorrhage into the omentum may well receive further study and it is believed that the case here reported may throw some light on the subject.

Case History, No. 657 B.—G. R., aged twenty-six, a clerk and football player, admitted to Roosevelt Hospital, June 30, 1910. Discharged cured, July 8. Diagnosis, cyst of omentum.

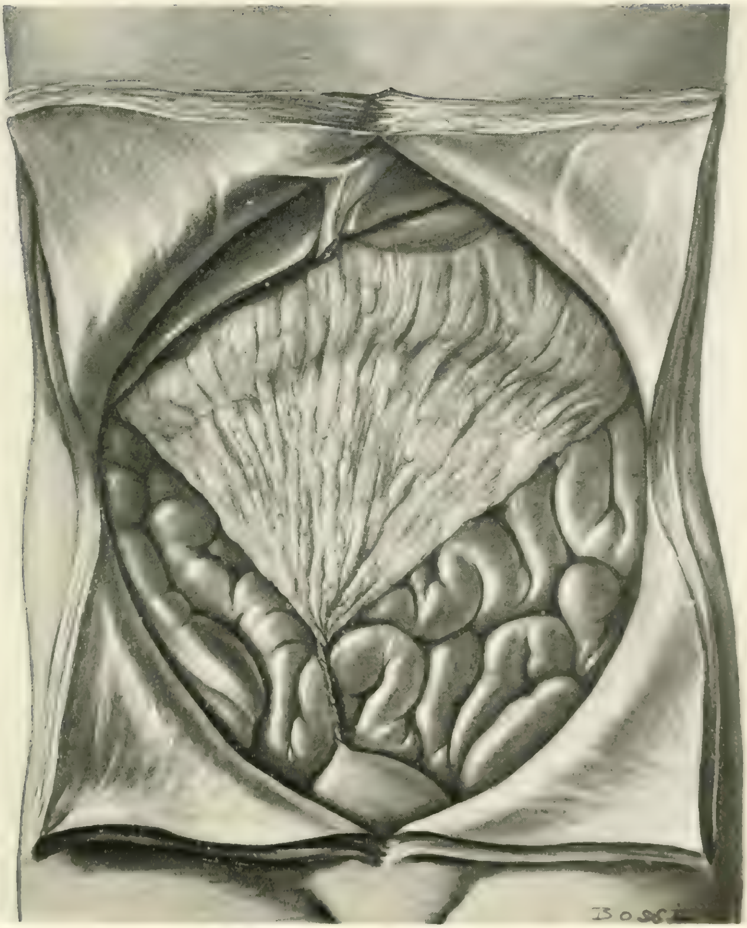
Chief Complaint.—Lump in abdomen.

Present Illness.—Fifteen months ago while straining at stool, he felt something "snap" inside of him, and immediately began to feel very faint. He collapsed for several minutes, then recovered, then went to bed for ten days on account of weakness and pain in abdomen. He was nauseated and vomited once or twice. After lying in bed for ten days he felt well again. About four months ago he noticed a lump in the left side of the abdomen about half as large as a hen's egg. This lump apparently increases and diminishes in size; he thinks it is slowly getting larger. There has been constantly a dull aching pain in the tumor. No pulsation noted. Patient is habitually constipated. No fever. Appetite good. Has had acute attacks of cramp-like abdominal pain, about six attacks.

Past History.—Negative for infectious or contagious diseases except measles. Cardiorespiratory, negative. Gastro-intestinal, no stomach symptoms. Constipation. Abdomen too full, patient says. Urinary, negative. No gonorrhœa or lues. Alcohol in moderation.

Family History.—Negative to neoplasm or tuberculosis. Father died of stomach trouble.

FIG. 1.



Diagrammatic drawing of omental cyst with torsion of its pedicle.

Physical Examination.—Patient is a well-nourished young man, who does not look to be acutely ill. He shows no abnormality excepting in the lower part of the abdomen, where a tumor can be felt. It is 2½ inches below the umbilicus and extends to the left from the median line. It seems about as large as an orange. It is firm, smooth, and apparently is not in anterior abdominal wall. Firm pressure over it causes pain. It is somewhat movable. No pulsation can be made out. No murmur is heard. Pressure seems to make no difference in size of tumor.

Operation.—Anæsthetic: gas and ether. Median incision. A cyst about as large as a grape fruit was found attached to the pelvic peritoneum; it had a pedicle above, which was composed of twisted omentum (see diagram). Its wall was thin. The tension of the fluid was moderate. A fold of peritoneum extended upward on to its anterior wall; when this was peeled down the cyst wall proper was found to be continuous with the omental peritoneum. The fluid was aspirated and found to be clear, thin, and watery. The cyst was then separated from its pelvic adhesions; its pedicle was ligated, and it was removed. On section the cyst wall was found to be composed of omental peritoneum and fibrous tissue into which this peritoneum was incorporated. Within this wall and pressed firmly against it there was a friable layer of coagulated fibrin. The patient made an uninterrupted recovery.

Pathological Report (Dr. Mortimer Warren).—The tumor was a cyst about the size of a large orange, and contained 8 to 10 oz. of clear fluid. It was covered with peritoneum. Beneath the peritoneum there was a rather thick layer which was bluish-green in color and very friable, breaking on being touched. The pedicle of the tumor was composed of mesentery twisted on itself many times.

Microscopical Examination.—Showed that the cyst wall was composed of fibrous tissue congested and infiltrated with round cells. It contained many blood-vessels and showed evidences of inflammation. The inner layer was coagulated fibrin and showed no definite cellular structure.

The cyst fluid was pale in color, sp. gr. 1008, albumin 1 per cent. (in bulk). There were a few blood-cells which apparently got into the fluid during the operation. Their examination showed a ratio of 216 red blood-cells to 36 white blood-cells.

A differential count showed: 4 per cent. polymorphonuclear cells; 60 per cent. lymphocytes; 36 per cent. endothelial cells. The fluid was apparently a transudate, not an exudate. There were no bacteria

Probable Method of the Formation of the Cyst.—The facts that this cyst wall was little more than thickened peritoneum and that there was a layer of coagulated fibrin within it, lead one to wonder whether it could have been the result of an omental hæmatoma. Furthermore, the patient's history suggests such a formation. The attack came on suddenly while he was straining, he felt as though something had given way, he fainted and had to be in bed for several days, he had been subjected to frequent traumatisms, and hence was more apt than the average person to have omental hemorrhage. One who believes the cyst to have been the result of hemorrhage should explain the absence of hæmoglobin in its contents, the very light specific gravity of its fluid, and the apparent increase in the size of the cyst and in the pain.

Absence of Hæmoglobin in Fluid.—Adami and Bradley have explained the disappearance of the hæmoglobin.

Adami,[2] writing of hemorrhagic cysts, says: "Extensive hemorrhages into the substances of sundry organs may result not in the ultimate absorption of the exuded fluid but in cyst formation. The hemorrhage leads to the destruction of the tissue of the infiltrated area; eventually a capsule is found around the exuded blood, but while this is proceeding, through the combined agencies of leucocytes and autolysis the bodies of the corpuscles and the cell débris undergo removal, as does also the diffused and altered hæmoglobin, so that, after a few weeks, the cyst is found to contain a thin, blood-stained fluid, and eventually all the contents come to be a clear serous fluid. The last indication of the hemorrhagic origin of such a cyst is the presence of modified blood pigment in and around the fibrous capsule. The organs in which such hemorrhagic cysts are specially liable to be found are the brain, goitrous thyroid, scalp of the newborn and children (cephalhæmatoma), pinnæ of ears (football players and lunatics) (othæmatoma)."

Bradley[3] has studied the same process in the thyroid gland, and has described seven thyroid cysts which showed hemorrhagic origin and illustrated different stages of cyst development and absorption of hæmoglobin.

Brain cysts which were the sequelæ of hemorrhages and which contained clear fluid have been very often described, and they offer very good examples of the process under consideration.

Light Specific Gravity of the Fluid.—In speaking of the fluid, Dr. Warren said that it seemed like the fluid of œdema, not like the fluid ordinarily found within a cyst. Its specific gravity, 1008, was much less than that of blood, which is about 1060. Its content of albumin, 1 per cent. (by bulk), was also a small fraction of that in blood-serum, which is about 50 per cent. when estimated by the same method.

Can the light character of this fluid be explained by the twisted pedicle of the cyst? One may well believe that it can. Much has been written about torsion of the omentum. In 1900 Wiener[4] tabulated seven cases; in 1905 Corner and Pinches[5] 53 cases, and in 1910 Finsterer[6] 72 cases, and records of a few other cases are to be found in the literature. Most of the cases (90 per cent.) have been associated with hernia.

The omentum has been twisted between two fixed points in 23 per cent. of the cases (Pretzsch[7]), its lower edge has been free in 77 per cent. This torsion is not so common as that of ovarian cyst pedicle and probably not so common as volvulus of the intestine. Either the existence of an omental hæmatoma or the adhesion of the omentum to the pelvic peritoneum would give conditions for omental torsion, and the existence of such a torsion in this patient is not to be wondered at. Torsion might easily cause œdema below the pedicle, and in a cyst with indefinite vascular walls this œdema might easily determine the character of the contained fluid; the watery elements being present in a larger proportion than in ordinary cysts.

The symptoms of torsion of the omentum have usually simulated those of strangulated hernia or appendicitis (sudden pain, nausea or vomiting, constipation, tenderness, rigidity, etc.), and the attacks of pain and the discomfort which this patient had were probably in large measure due to the omental torsion.

Summary.—The cyst formation in this case is believed to have been due to the following elements:

1. Hemorrhage into the greater omentum, forming a hæmatoma.

2. Absorption of the hæmoglobin and degeneration of the blood-cells, as described by Adami and Bradley.

3. Torsion of the omentum, as in cases tabulated by Finsterer and others, with consequent œdema and transudation of the watery elements of the serum into the cyst cavity.

The attacks of pain were similar to those which have been described by patients with omental torsion.

The condition must be a rare one, but in these days of careful study of abdominal conditions, it surely has a practical as well as an academic bearing.

REFERENCES.

[1] Hasbrouck: ANNALS OF SURGERY, 1908, vol. xlviii, p. 207.
[2] Adami: Principles of Pathology, 1908, vol. i, p. 794.
[3] Bradley: Journal of Experimental Medicine, vol. i, p. 401.
[4] Wiener, Jos., Jr.: ANNALS OF SURGERY, vol. xxxii, p. 648.
[5] Corner and Pinches: American Journal of the Medical Sciences, vol. xxx, p. 314.
[6] Finsterer: Brun's Beiträge zur klin. Chir., 1910, vol. lxviii, p. 52.
[7] Pretzsch: Brun's Beiträge zur klin. Chir., 1906, vol. xlviii, p. 118.

LINITIS PLASTICA (CIRRHOSIS OF STOMACH).

WITH A REPORT OF A CASE CURED BY GASTRO-JEJUNOSTOMY.

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THE term *linitis plastica* was used by Brinton to designate a special disease of the stomach, benign in nature, characterized, pathologically, by a diffuse or circumscribed increase in the connective tissue involving chiefly the submucosa, and to a lesser degree the other layers, giving rise to a marked thickening of the stomach walls with a corresponding diminution in its lumen; clinically, by its insidious onset, its slow progressive gastric symptoms, its cachexia, and fatal termination.

Nomenclature.—In searching the literature the following synonyms for the disease are found: (1) chronic interstitial gastritis; (2) sclerosis of stomach (Sneller); (3) fibroid induration (Handfield Jones); (4) fibroid disease of pylorus (Haberson); (5) hypertrophy with induration (Cruveilhier); (6) submucous hypertrophy; (7) submucous sclerosis with chronic gastritis and callous retroperitonitis (Hanot and Gombault); (8) hypertrophic stenosing gastritis (Boas); (9) hypertrophic stenosis of pylorus (Lebert); (10) fusocellular sarcoma (Lyonnet); (11) plastic linitis (Brinton); (12) cirrhosis of the stomach; (13) endogastritis obliterans (Leersum); (14) Magenschrumpfung; (15) Zuckergussmagen; (16) hypertrophy of the stomach (Fox); hypertrophic sclerosis of the submucosa (Bouvert); (17) atrophy of stomach (Fenwick); (18) Cirrhotische Verkleinerung des Magens (Nothnagel); (19) cancer conjunctif sous-muquex (Bard et Garret); (20) neurofibromatose carcinomatose (Curtis); (21) gastro-intestinal sclerostenosis (Krompecher).

History.—The condition of scirrhus of the stomach had been recognized two to three centuries before Brinton's description. These early descriptions were scattered and incomplete, Lieutaud (1779), Voegtel (1804), Pohl (1804). In the second quarter of the nineteenth century the observations became more frequent. In France, Andral (1835), Cruveilhier (1835), Monnert (1841), Salse (1844), Bérault (1847), Lebert (1845), Boyer (1848), Broca (1850) described the condition. Andral's, Cruveilhier's, and Broca's descriptions are clear-cut, and definitely state that the lesion is benign. Lebert recorded a case in which the stomach, colon, and rectum were involved.

In Germany Gluge (1850) described a case of complete involvement of the stomach, Brant (1851), one in which the lesion was found in the stomach and cæcum. By these authors the lesion was held to be benign. In Austria Rokitansky (1859) stoutly maintained that the submucous hypertrophies were nothing else than fibroid cancers.

To Brinton (1854) belongs the credit of attempting to establish it as a separate and distinct disease of the stomach. He gave to it the name linitis plastica (cirrhotic inflammation).

Of the terms offered, Brinton's baptismal name has won the most favor. This is especially true of the French and Italian literature. In his search for a distinctive title he suggests "that the inflammation of the filamentous network of areolar tissue, which seems to be the main characteristic of the lesion, might be well expressed by such a word as linitis" (from the Homeric λίνεον, ex lino factum). He rejects the term interstitial gastritis "as the involvement of the mucous membrane is inconstant, late, and incidental"; hypertrophy, as it is an evident misnomer; fibroid infiltration, because it is not a true histological likeness.

Contemporary with Brinton the English observers, Handfield Jones, Wilks, Fox, Habershon, Hare, and Quain reported cases and considered the affection benign. For a considerable period following Brinton's observations, the view that the lesion was benign met with the most favor. This was materially strengthened by the admirable articles of Hanot and Gombault (1882), Tourlet (1902). On the other hand, Garret (1892), Bret and Paviot (1894), Hoche (1903), Schacher (1903), forcibly declared the lesion to be malignant. This later conclusion dominates the French and Italian literature of to-day.

Opposed to this we have the operative findings and results of von Eiselberg (1902), Roux (1903), Sheldon (1904), Jonnesco and Grossman (1905), Deaver (1906), Lyle (1908), and the most excellent article of Kurt von Sury (1907).

Nature and Pathogenesis.—The pathogenesis of this affection is not yet clear, and it is impossible to say which of the many theories is correct. Brinton was well aware of the difficulty of making any definite statement, and warns that nothing short of "careful histories of cases during life and still more careful examinations of the corresponding specimens after death, in a far larger number than are at present at our disposal, can afford materials for any safe deductions." He recognizes the fact that a careful examination of the stomach may not reveal anything suggestive of cancer, yet the adjacent glands, lungs, liver, etc., may yield cancerous deposits.

Among the numerous theories that have been advanced are: that it is a stage of advanced gastritis; a primary atrophy (Fenwick); a result of chronic passive hyperæmia due to cardiac insufficiency (von Sury). Pedrazzini believes it to be a manifestation of senility; Huchard, an arteriosclerosis; and Poncet, Leriche, Villiers, and Phillippen claim that it has a tubercular element. Bouvert thinks it is due to a lymphatic obstruction; Wilks, that it is a primitive sclerosis of the submucosa; Garret and Bard, that it is a secondary sclerosis following a fusiform sarcoma. Bret and Paviot maintain that it is secondary to an infiltrating epithelioma. Shacher holds that it is an epithelioma pure and simple, starting from the mucosa, infiltrating the gastric walls, causing an irritative connective-tissue hyperplasia, this irritation producing epithelial buds. Hoche maintains that it is an infiltrating epithelioma arising from an old cicatrizing ulcer. Danel's view is similar, but he places special stress on the cancerous involvement of the glands. Hanseman, in his work on endothelioma, says that many of the so-called scirrhous infiltrations of the stomach are endothelioma.

Delebet claims that linitis plastica is a diffuse cancer of the stomach. "The interest is not so much the question of the nature but how it advances. In linitis plastica secondary nests have been observed in all parts of the intestine; these could be attributed to primitive cell nests because they appear not in the mucosa, but in the cellular or muscular layers and others on the mesenteric side." They are due to a retrograde invasion of the lymphatics; they present a phenomenon identical to the one Handley has described in the breast under the name of permeation; this mechanism is not habitual, on the contrary it is only in these cases. The secondary nodules, which in ordinary cancers of the stomach are most often found in the liver, are lacking in a great majority of recorded cases.

In all these theories only two distinct ideas have been expressed: one, that linitis plastica is a special affection of an indefinite nature and cause; the other, that linitis plastica is a special form of scirrhous cancer.

Krompecher holds that gastro-intestinal sclerostenosis is not a mere disease of the pylorus, but is found in the intestines and peritoneum, and that it is the result of a chronic venous œdema caused by cardiac insufficiency and arteriosclerosis; and that the pathological process bears a close relation to scleroderma. (See Krompecher's conclusion, Case 70.)

Pathology.—Two forms are recognized, the local and the general. In the localized form we find indurated plaques on different portions of the viscus. This is rare. Viti's case is an example. The more common variety of this form is the one which is found in the pyloric region, forming a plaque of varying extent, often encircling and stenosing the pylorus.

Examples of this are the cases of Habersohn, Tilger, Boas, Chaput and Pillet, Brissaud, Oettenger and Tourlet. It is natural to suppose that the obstruction to the pylorus would lead to a dilatation of the stomach. This is seldom met with (exception, Nauwerk). The infiltration shades insensibly into the normal stomach tissue, but stops abruptly at the duodenum. An exception to this is Marcy and Griffith's case, where the infiltration extends to the duodenal entrance of the common duct. Herrenschmidt's case, in which the process has extended into the duodenum, pancreatic ducts, and common bile-duct, cannot be considered as an exception, for it is not a true linitis plastica.

In the generalized form the stomach may be normal in size, dilated, or contracted. Contraction is the rule, dilatation the exception. In a typical case we find a shrunken, thick-walled tube lying transversely across the epigastrium, suggesting by its size a segment of the large intestine. Often the walls of such a case are so rigid that if the stomach be removed it does not collapse but maintains its original shape. The peculiar dull grayish color of the peritoneum gives to the surface of the stomach a scarred looking appearance.

On section the stomach wall is greatly increased in thickness. Brinton says it may be six to eight times as thick as the normal wall. Despite the infiltration the layers remain distinct.

In the advanced cases all the coats are involved, the most marked involvement being in the submucosa, subserosa and serosa. According to Brinton the submucosa is ten to twenty times its normal thickness, the serosa and subserosa seven to ten times, the muscularis five to eight times, and the mucosa two to three times. The mucosa is often normal in appearance, "the secretory structures remaining substantially healthy," or it may be thickened and merged into the adjacent layers. Primitive atrophy is infrequent, ulceration rare. When there is marked involvement of the walls the knife fairly creaks as if it were cutting through cartilage. The cut section is comparatively bloodless, and no cancer juice can be expressed. Tumor formation is uncommon; it is a flat infiltrating process. The lymphatic glands are small and hard, sometimes enlarged.

In the majority of cases evidences of an associated subacute or chronic peritonitis are prominent: lymph on the coils of the intestine, fibrous adhesions, ascites, thickening and opacities of lesser and greater omentum, white waxy-like plaques on the visceral and parietal peritoneum, thickening of the retroperitoneal tissue (retroperitoneal callus of Hanot and Gombault).

Analogous lesions are found in the colon, rectum, and small intestine. These lesions start from the mesenteric attachment and suggest a retrograde lymphatic involvement. These secondary involvements are considered by Bret and Paviot to be cancerous. Krompecher concludes that they are benign and suggests the similarity between the lesions and scleroderma.

Microscopical Examination.—The mucosa may be normal, or it may show evidences of a chronic productive or atrophic gastritis. In the advanced cases we meet with cystic dilatation of the tubules, constrictions, and other anomalies due to the pressure effects of the infiltrating connective tissue. This infiltration may lead to a sclerosis with atrophy, causing a complete disappearance of all the glandular elements (example, Osler's case).

The most marked and constant lesion found is a diffuse hypertrophy of the connective-tissue elements of the submucosa. The bundles of white connective tissues traverse the layers in irregular bands, surrounding the blood-vessels and interlacing with one another. The blood-vessels may show signs of endarteritis. The resemblance which this tangled interlacement of fibres bears to the weave of sail-cloth suggested to Brinton's mind the term " linitis."

It is a disputed question whether the epithelial cells found in the submucosa and muscularis are carcinomatous or whether they spring from the endothelium lining the normal lymph spaces. The majority of observers consider these nests to be evidences of cancer. In the muscularis there is a combination of hypertrophy and atrophy of the muscle fibres. Bands of connective tissue are found passing from the submucosa through the muscularis to the subserosa. The subserosa shows a marked connective-tissue infiltration, the serosa a destruction of the endothelial cells. The lymphatic glands when involved show a chronic connective-tissue fibrosis.

In forming a mental picture of this lesion we are struck by the sharp contrast between the integrity of the mucosa with its absence of ulceration and the enormous thickening of the submucosa.

Etiology.—It is a disease of adult life. In Table A (true linitis plastica), the total number of cases in which the age is given is 64. Excluding three of these (Nos. 8, 55, 57) which cannot be properly admitted, the remaining 61 are grouped as follows:

Between 20–30 years	6 cases
Between 30–40 years	13 cases
Between 40–50 years	17 cases
Between 50–60 years	11 cases
Between 60–70 years	12 cases
Between 70–80 years	2 cases

In Table B (so-called malignant linitis plastica), the total number of cases in which the age is given is 54. Excluding Nos. 36 and 50, the remaining 52 are grouped as follows:

Between 20–30 years	6 cases
Between 30–40 years	9 cases
Between 40–50 years	10 cases
Between 50–60 years	12 cases
Between 60–70 years	11 cases
Between 70–80 years	4 cases

It is more often found in men than in women. In Table A (true linitis plastica), there are 41 men; 22 women. Sex not given in 15 cases.

In Table B (so-called malignant linitis plastica), there are 33 men; 19 women. Sex not given in 5 cases.

A considerable number of the cases give a history of cardiac or arterial trouble; a few give an alcoholic history. Syphilis is not a factor. Multiple peptic ulcers have been advanced as a cause. Poncet, Leriche, Villiers, and Phillippen believe that tuberculosis plays an important part. Occupation trauma was noted in the cases of Hare, Snellen, and Schacher. Ascites and peritonitis are results, not causes.

Symptoms.—There were no symptoms referable to the stomach in Viti's case, the antemortem diagnosis being chronic bronchitis and arteriosclerosis. Halipré's and Beaurain's second case gave a rheumatic history, their third case died of diabetes; leucoplakial plaques were found in the mouth. In Bouchard's and Kurt von Sury's cases the stomach symptoms were overshadowed by arteriosclerosis and cardiac complications. The diagnosis was not made until a few months before death. In the great majority of cases the onset is insidious; in a few abrupt. For months or years there is an indefinite history of dyspepsia, then definite progressive gastric symptoms appear, followed by severe anæmia, starvation, cachexia, and death.

In the first stage the symptoms are vague and inconstant. they are best described by the term indefinite dyspepsia. These symptoms gradually give way to a more or less constant anorexia, occasional vomiting, and an indistinct gastric pain and tenderness.

The involvement of the peritoneum brings its own train of symptoms according to the organs and structures involved; constipation, attacks of partial obstruction, and marked diarrhœa have been reported; of these diarrhœa is the most common. Ascites and œdema may come on early, but as a rule they are terminal symptoms.

A transverse sausage-shaped tumor or a sense of resistance was reported in 13 cases. The motility of the tumor depends on the amount of peritoneal involvement. Hæmatemesis is not common; melena rare. An increase of HCl is uncommon, a decrease or absence of free HCl is the rule. Lactic acid is present in a small number of cases.

The vomiting, at first inconstant and inconsequent, becomes more frequent; towards the last it is incessant. If the lesion be near the cardia it simulates a regurgitation from an œsophageal stricture. The vomiting is never that of a dilated stomach, but of a small rigid organ which is intolerant to the quantity of food rather than the quality. The patients complain of a suffocative tightness in the epigastrium; this distressing symptom is partially relieved by vomiting. The stomach cannot be distended and will only hold small quantities of fluid.

Valuable information can be obtained from an X-ray examination. In Jonas's case the shadow showed a small stomach of the infantile type drawn well up under the ribs, the outline of the shadow was sharp, no peristaltic wave was noted. Pressure on the stomach wall forced the bismuth paste into intestine.

Course.—Unrelieved by surgical measures, the disease is uniformly fatal. In 43 cases of true linitis plastica, in which the duration of the symptoms was given, the shortest was 3 months, the longest 20 years, the average 49 months. In 37 cases of the so-called malignant type, the shortest duration was one month, the longest 15 years, the average 23.9 months.

Diagnosis.—The diagnosis of linitis plastica is rarely made during life; it comes to light as a surprise of the operating table or the autopsy room.

Boulton (1862) reports a case in which the diagnosis of linitis plastica was made during life. At autopsy the gross findings were those of linitis plastica, but as no microscopical examination was made, the honor of the first diagnosis which was proven by autopsy and microscopical examination goes to Deguy (1896); the credit of the second goes to Osler (1901).

An accurate clinical diagnosis between scirrhus cancer and linitis plastica is impossible. After the most careful, painstaking microscopical examinations failure has been recorded (Curtis's case). The points in favor of its benignity are: a history of cardiac insufficiency, general arteritis, pericarditis, etc.; its occurrence in younger people; its long duration; the absence of evidences of dilatation of the stomach; the slowly decreasing capacity of the stomach; the infrequency of hæmatemesis and melena; the character of the cachexia, it being a starvation rather than a poisoning. The size, distensibility, and the presence or absence of a pyloric stenosis can be determined by the X-ray and physical means. If a small shrunken stomach without pyloric tumor formation be found, the question of a linitis plastica might arise (Jonas's case).

The condition has been mistaken for (1) movable kidney, (2) movable spleen, (3) movable transverse colon, (4) portal cirrhosis, (5) pyloric stenosis with ulcer, (6) gastric ulcer with degenerative changes, (7) chronic peritonitis, (8) tubercular peritonitis. The diffuse infiltrating hypertrophic type of syphilis of the stomach could be readily mistaken for linitis plastica. Here we would depend on the history, the results of a course of anti-syphilis treatment, and the presence or absence of the Wassermann reaction.

Treatment.—The practical difficulties in making a diagnosis between this lesion and scirrhus cancer, and the possibility of it being a precancerous state, make gastrectomy the operation of choice provided the technical conditions are satisfactory. The condition of the patient, the presence of extensive adhesions, etc., may make gastro-enterostomy advisable. If gastro-enterostomy is impracticable, jejunostomy in Y gives a better clinical result than gastrostomy. Marchant and Domulin describe lesions similar to those of linitis plastica, in which the patients have been apparently cured by simple exploratory laparotomy and by gastro-enterostomy.

Total gastrectomy—three cases.

Ribera (1895), reported by Boeckel. Total gastrectomy with œsophagoduodenal anastomosis; well four years after. This is the first operative case on record. It was a marked case of linitis plastica with numerous adhesions between the stomach and the parietal peritoneum. At operation a portion of the abdominal wall was resected, as it was thought to be infiltrated with cancer. Microscopical examination proved it to be benign. (Table A, No. 53.)

Van Leersum (1900). First performed pyloroplasty (Heineke-Mikulicz), no improvement; three months later did a total gastrectomy with œsophagojejunal anastomosis. (Table B, No. 38.)

Jaboulay (1904), reported by Gayet and Patel. Total gastrectomy; rectum removed one year later for a similar lesion. (Table B, No. 16.)

Partial gastrectomy—thirteen cases.

Monprofit (1898). Resection of one-third of the stomach; gastro-enterostomy in Y. (Table A, No. 28.)

Debét (1900), reported by Brissaud. Pylorectomy; well four months later. (Table B, No. 10.)

Vautrin (1900). Partial gastrectomy; gastroduodenal anastomosis; died two and one-half years later of acute phthisis; no autopsy. (Table B, No. 17.)

Weiss (1900), reported by Schacher. Partial gastrectomy, two-thirds. Gastroduodenal anastomosis; well two and one-half years after. (Table B, No. 13.)

Chaput (1901), reported by Tourlet. First gastro-enterostomy; then pylorectomy; well ten months after. (Table A, No. 30.)

Poncet, reported by Mouriquard. Partial gastrectomy with gastro-enterostomy; fourteen days after the original operation the wound broke open, gastric fistula formed; spontaneous healing; well 22 months after. (Table B, No. 19.)

Rossi (1903). Partial gastrectomy; patient died three months later from intestinal obstruction, the result of the operation. (Table B, No. 29.)

Duret (1904), reported by Danel. Partial gastrectomy with gastro-duodenal anastomosis; died three days later from shock. (Table B, No. 45.)

Tasini (1906), reported by Morone. Partial gastrectomy; well 14 months later. (Table B, No. 43.)

Quenu (1906). Pylorectomy with posterior gastro-enterostomy. (Table B, No. 25.)

Quenu (1906). Extensive gastrectomy with posterior gastro-enterostomy; died three and one-half years after. (Table B, No. 26.)

Lecene (1908). Pylorectomy with gastro-enterostomy. (Table B, No. 24.)

Temoin (1910), reported by Roussy. Pylorectomy. No clinical details. (Table B, No. 59.)

Gastro-enterostomy—nine cases.

Chaput (1906), reported by Chaput and Pilliet. Gastro-enterostomy; died two days later. (Table A, No. 25.)

Triconni (1902), reported by Cignozzi. Gastro-enterostomy in Y; died eight days later from inanition. (Table B, No 33.)

Vautrin (1903), reported by Vautrin and Hoche. Gastro-enterostomy; two months later an entero-anastomosis for vicious circle; died next day. (Table B, No. 11.)

Sheldon (1903). Anterior gastro-enterostomy; well at the present time (personal communication). (Table A, No. 46.)

Roux (1904). Anterior gastro-enterostomy; well three and one-half years after. (Table A, No. 31.)

Deaver (1906). Posterior gastro-enterostomy; died four years after; cause of death not known (personal communication). (Table A, No. 47.)

Lyle (1907). Posterior gastro-enterostomy; well at the present time. (Table A, No. 71.)

Derveau (1909). Posterior gastro-enterostomy impossible on account of adhesions. Anterior gastro-enterostomy. Died of inanition four months later. This was an extreme case of linitis plastica. Derveau says he should have done a jejunostomy in Y. (Table A, No. 58.)

Pyloroplasty—one case. See Van Leersum. (Table B, No. 38.)

Gastrostomy—two cases. (*a*) See Jonnesco and Grossman. (Table A, No. 34.) (*b*) Stretton (1909). Gastrostomy; died. (Table B, No. 27.)

Jejunostomy—four cases.

Wickerhauser (1902), reported by Cackvoic. Gastrectomy indicated but impossible; jejunostomy performed; died seven days later from peritonitis. (Table B, No. 34.)

Cackvoic (1902). Jejunostomy; died seven days later from hypostatic pneumonia. (Table B, No. 35.)

v. Eiselberg (1902). Jejunostomy (Witzel). Well five years after. Eighteen days before this operation an exploratory laparotomy had been performed with the object of making a posterior gastro-enterostomy; this was found to be impossible. The abdomen was closed as the patient's consent for the formation of an artificial fistula had not been obtained. (Table A, No. 48.)

Jonnesco and Grossman (1905). A typical gastrostomy was attempted under difficult conditions; it was not satisfactory, so a jejunostomy in Y was performed. Patient improved. A few weeks later an attempt was made to close the gastric fistula. Patient died two days later. (Table A, No. 34.)

Manual Dilatation.—Finney (1901), reported by McRae. Manual dilatation for hour-glass constriction; died four days later. (Table A, No. 36.)

CONCLUSIONS.

1. Diffuse fibrosis of the stomach occurs without cancer.

2. A large number of the cases reported are frankly cancer and have no claim to be termed linitis plastica. On the other hand, some of the cases reported as linitis plastica are

scirrhous cancers. "This is no doubt true of some of Brinton's cases, for at that period the microscopical examinations were of necessity inadequate." (Welch, personal communication.)

3. The clinical diagnosis is rarely possible and at the best is always problematic. The microscopical diagnosis necessitates a careful and prolonged search for nests of cancer cells in order to exclude scirrhus.

4. There is a possibility that the condition may be a precancerous state, bearing somewhat the same relation to scirrhous cancer that gastric ulcer bears to gastric carcinoma.

5. The treatment is surgical.

TABLE A.—BENIGN.

Abstracts of Reported Cases of Linitis Plastica.

1. CARRIÈRE, male, age 52. Gastric symptoms for four months; no tumor felt. Autopsy; hypertrophy of the stomach most marked in the pyloric region but extending on lesser curvature and anterior wall. Microscopical: benign.

2. TROUSSEAU, male, age 25. Active gastric symptoms for three months; palpation gives a suggestion of thickened stomach wall. Autopsy: small, contracted, thick-walled stomach; no tumor. Diagnosis before autopsy: carcinoma. Microscopical: benign linitis plastica.

3. BALLET, female, age 59. For several months pain, vomiting, and tenderness; alcoholic history. Autopsy: ascites; stomach about size of transverse colon; surface smooth; no adhesions; no ulceration of the mucosa; tissue hard and grated under the knife. Microscopical: marked connective-tissue increase in the submucosa. Original diagnosis: carcinoma of the stomach; revised: benign linitis plastica.

4. MARIGNAC, female, age 29. For twenty years obstinate constipation alternating with diarrhœa; active gastric symptoms for six months; death from intestinal obstruction. Autopsy: ascites; stomach small, walls very thick, adhesions between stomach and colon; numerous small, white fibrous patches on the mesentery, peritoneum, and omentum; on rectum and colon contractions of fibrous tissue. Microscopical: lesions in the stomach, colon, and rectum similar; mucosa intact; submucosa four to five times normal thickness; muscularis hypertrophied; peritoneum thickened; seems to be a case of linitis plastica of the stomach, colon, and rectum.

5. NOTHNAGEL, male, age 23. Gastric disturbances for eight years; progressive pernicious anæmia. Autopsy: pernicious anæmia with small, thick-walled stomach: tissue grated under knife. Microscopical: suppression of the gastric glands and replacement by connective tissue; muscu-

laris and submucosa greatly thickened; glands non-malignant; case of pernicious anæmia with linitis plastica of the stomach.

6. Broca, female, age 50. Gastric symptoms for seven years; pain and vomiting; no blood; tumor in the epigastrium. Autopsy: small thick-walled stomach. Microscopical: benign.

7. Snellen, male, age 52. Progressive gastric symptoms for two years; tumor in epigastrium. Autopsy: hypertrophy of the submucosa. Microscopical: mucosa shows lesions of chronic gastritis; submucosa compact, fibrous infiltration; hypertrophy of the muscularis with fibrous infiltration.

8. Leudet, male. No clinical symptoms given. This case is quoted by Tourlet, but the evidence is not sufficient to call it a case of linitis plastica.

9. Schoch, male, age 32. Gastric symptoms for sixteen years. Autopsy: dilatation of the stomach with hypertrophy in the pylorus. Microscopical: marked thickening of the coats, most marked in the muscularis. This case is quoted by Tourlet, but seems to be a case of pyloric stenosis with dilatation of the stomach rather than a case of linitis plastica.

10. Wilks, female, age 44. Alcoholic; no previous history is stated; present history dates back several weeks; apparently died of peritonitis. Autopsy: ascites; chronic fibrous peritonitis with numerous adhesions; omentum and colon show marked thickening; stomach small, thick-walled, and rigid. Microscopical: hypertrophy of the muscularis with marked involvement of the submucosa; peritoneum dense and fibrous; transverse colon, sigmoid, and rectum showed a similar lesion to that of the stomach; no involvement of other abdominal organs.

11. Hare, female, age 33. Moderately alcoholic; gastric symptoms for four to five years; small tumor in the epigastrium. Autopsy: small, thick-walled stomach contained only four to five ounces; numerous adhesions; on section, hard, pearly gray in color; 1.5 to 2.5 cm. thick. Microscopical: no ulceration of the mucosa and all coats including the peritoneum showed connective-tissue changes. Diagnosis before autopsy was cancer of the spleen or of the peritoneum; revised diagnosis: linitis plastica. This patient was a laundress and was in the habit of pressing the iron against her stomach.

12. Nauwerk, female, age 23. No clinical symptoms given. Autopsy: stomach fills two-thirds of the abdominal cavity; at the pylorus there is a fibrous tumor formed by the hypertrophy of the walls of the stomach and duodenum; no ulceration; no peritonitis; no glandular involvement; thickness 14 mm. Microscopical: benign.

13. Henrot, male, age 50. Alcoholic; terminal symptoms were of three months' duration; loss of appetite, and diarrhœa; ascites, œdema of extremities; no tumor, epigastric pain, or vomiting. Autopsy: volume normal; both orifices contracted; walls very thick and resistant; no ulceration; fibrous plaques on small and large intestine; mesentery and omentum thickened. Microscopical: stomach and contracted portions of the small and large intestine showed the lesions of linitis plastica.

14. DURAND-FARDEL, reported by Letulle. Alcoholic; for eight months has presented classical symptoms of cirrhosis of the liver. Autopsy: stomach sausage-shaped; walls hard and thick; cut like cartilage; omentum shrunken and hard; liver cirrhotic. Microscopical: marked case of linitis plastica. Before the microscopical examination this was thought to be carcinoma of the stomach.

15. SCHMIDT, female, age 46. Alcoholic; gastric symptoms for eight years; vomited blood once; no tumor. Autopsy: ascites; diminution in size of all abdominal organs; stomach very small; walls hard and thick; no tumor, ulceration or scars. Microscopical: mucosa showed changes of the connective-tissue type; glands obliterated.

16. HANOT and GOMBAULT, male, age 45. For one year has complained of weakness and distention of the stomach; lately marked ascites and œdema of extremities; no tumor or vomiting. Autopsy: tuberculosis of the apices of the lungs; ascites; great and small omentum shrivelled up; adhesions between the pylorus, colon and neighboring structures; numerous glands; stomach small, thick walled; mucosa smooth and thick; lesions most marked in the region of the pylorus. Microscopical: non-malignant linitis plastica; glands chronic adenitis.

17. DUBUJADOUX, male, age 23. Non-alcoholic; for three months vague pains in the right hypochondrium; lately jaundice; some ascites and œdema around the ankles; no tumor. Autopsy: ascites; cirrhosis of the liver; stomach thickened at the pyloric end; mucous membrane pale and thick; marked increase in the submucosa and muscularis. Microscopical: benign linitis plastica.

18. FORMAND, male, age 38. For ten months has had dyspepsia and vomiting; lately the vomiting has assumed the characteristic of an œsophageal regurgitation; symptoms disappeared a short time before death; no hematemesis. Autopsy: stomach very small, walls hard, 2.5 cm. thick; volume 130 to 150 c.c. On the posterior wall there is an ulcer, the base of which is the spleen; the lesion was thought to be cancer, but on microscopical examination it proved to be benign linitis plastica.

19. KAHLDEN, female, age 60. Vague gastric trouble for one year and a half; vomitus contained blood during the last weeks; ascites; tumor. Autopsy: chronic fibrous peritonitis; atrophy and sclerosis of the omentum and stomach. Microscopical: diffuse connective tissue infiltration of all the walls of the stomach; the glands of the mucosa have largely disappeared.

20. VITI, male, age 68. Died with symptoms pointing to a chronic bronchitis and arteriosclerosis. Autopsy: small thick-walled stomach; no tumor; no ulcer; no stenosis of the pylorus. Microscopical: lesions of diffuse sclerosis throughout stomach; marked thickening of the mucosa; hypertrophy of the muscularis; serosa not involved.

21. ROSSINI, male, age 49. Gastric symptoms for fourteen years; vomiting for ten; no tenderness or tumor; no hematemesis. Autopsy: stomach, greater curvature reaches to the level of the umbilicus; mucosa grayish-white with black patches; a mild stenosis of the pylorus due to

hypertrophy. Microscopical: mucosa infiltrated with connective-tissue; glandular epithelium normal in some portions, absent in others, and in still others shows hyaline degeneration; some of the gland tubules are cystic. Clinical diagnosis before autopsy was chronic gastritis; stenosis of the pylorus with gastrectasis. A few days before death fibrous cancer of the pylorus. Linitis plastica.

22. Rosenheim, female, age 58. Symptoms for fifteen months; loss of appetite; pyrosis; nausea, tenderness, progressive emaciation, tumor and anachlorhydria, lactic acid present. Microscopical: showed a simple hypertrophy of the pyloric region; mucosa shows the lesion of an atropic gastritis. The clinical diagnosis before autopsy was pyloric cancer.

23. Tillet, male. Duration of symptoms not stated. Complains of general weakness, dyspepsia, etc., without vomiting. Autopsy: stomach dilated; walls thick and cartilaginous, peritoneum not involved. Microscopical: hypertrophy of mucosa; connective-tissue infiltration of all the walls. Linitis plastica, benign.

24. Gabbi, female, age 62. Gastric symptoms for several months; pain and vomiting acute in latter stages; anachlorhydria, lactic acid present; no blood; transverse tumor. Autopsy: ascites; grayish-white plaques resembling drops of wax on parietal and visceral peritoneum; stomach small; walls thick and hard; mucous membrane thrown into folds, pale; no ulceration; glands of the lesser curvature enlarged; similar thickenings in the intestine, most marked at the ileo-cæcal junction. Microscopical: hypertrophy of all the layers of the stomach, most marked at pylorus; in the different layers the maximum change is in the submucosa. Linitis plastica, benign. Microscopical examination of the intestinal lesions shows them to be benign.

25. Pilliet, male, age 55. Symptoms for about one year; lately, constipation and vomiting; hematemesis and melena; HCl present. Operation by Chaput. Thick walled, hypertrophied stomach; gastro-enterostomy; death 48 hours later. Autopsy: Microscopical: interglandular gastritis; marked involvement of muscularis and submucosa; linitis plastica; non-cancerous. (Cornil.)

26. Deguy, male, age 57. Two previous attacks of acute articular rheumatism; gastric symptoms for over a year. The character of the symptoms led to the belief that this was an œsophageal condition; this, however, was ruled out by the use of a stomach tube; diffuse mass. Autopsy: small, thick walled, rigid stomach; no adhesions. Microscopical: linitis plastica, benign. (Cornil.) This is the first recorded case in which the diagnosis was made during life and sustained by microscopical examination after death.

27. Pedrazzini, male, age 66. Has been in the hospital a month; loss of appetite; pain in the epigastrium; transverse tumor. Autopsy: small, hard, thick-walled stomach; section cartilaginous; pearly gray in color; mucosa pale and anæmic; all coats involved; most noticeable in submucosa. Microscopical: linitis plastica, benign.

28. Monprofit, male, age 32. For two years pain, vomiting and constipation; movable tumor about the size of an egg. Operation: mass occupying one-third of the inferior portion of the stomach; resection of the stomach. Microscopical by Pilliet: Pseudo tumor composed of chronic inflammatory tissue, involving all the layers of the stomach.

29. Huchard, male, age 60. Alcoholic; chronic rheumatism; signs of atrophic cirrhosis with ascites; for six months aortic insufficiency. Diagnosis before autopsy: arteriosclerosis; stomach, sclerotic process involving all the walls; near the pylorus the lesion has a gross appearance of cancer. Microscopical: a simple sclerotic process.

30. Tourlet, from Ottenger's service, male, age 33. Gastric symptoms for eight years; progressive increase; no hematemesis; extreme constipation and diminished HCl; mass. Operation by Chaput: first, gastro-enterostomy; second, pylorectomy. Well ten months afterward. Gross and microscopical examination show it to be benign linitis plastica. Ottenger's opinion: inflammatory in nature and has chronic lymphatic œdema as its basis.

31. Roux, male, age 33. Duration of gastric symptoms not given; felt full after meals; food did not seem to pass; later vomiting; no blood; no melena; anachlorhydria; transverse tumor. Operation: gastro-enterostomy by Roux. Hard, tube-like stomach; walls greatly thickened. Operation difficult due to adhesions and thickness of walls. Patient well three years after operation. Article excellently illustrated.

32. Smith, female, age 34. Pain and vomiting; no tumor; small, hard, thick-walled stomach; greatest involvement region of the pylorus. Microscopical: linitis plastica, benign. Smith reports another case, but as no microscopic examination is given, it is not included.

33. A Jacobi, male, age 60. Gastric symptoms for more than six months; vomiting for six months. Diagnosis before autopsy was cancer of the stomach. Stomach was thick-walled and shrunken to the size of the small intestine; shows a progressive contraction of the stomach and gastric hypertrophy. Microscopical: benign. (Personal communication.)

34. Jonnesco and Grossman, male, age 42. Gastric symptoms for three years; pain, vomiting and tenderness; no tumor; at 52 cm. from the teeth stomach tube encounters an obstruction; stomach will only hold from 30 to 40 c.c. Operation: a typical gastrostomy attempted under difficult conditions due to the thick, hard walls; result unsatisfactory so jejunostomy performed; on account of a leakage an attempt was made to close the gastric fistula; the patient died two days after. Autopsy: shows the peritoneum free; no adhesions; stomach irregular ovoid in shape; capacity 40 c.c.; mucosa, no ulceration; section of the stomach grates under the knife and is pearly gray in color. Microscopical: enormous thickening of the submucosa; mucosa very little changed; muscularis infiltrated with connective tissue; serosa endothelium normal; connective-tissue in the submucosa Linitis plastica, benign. Good article with excellent illustration.

35. v. Sury, male, age 60. Was treated for cardiac disease, then a diagnosis of carcinoma of the stomach and omentum with ascites was made. Had had stomach trouble for three years but the symptoms were overshadowed by the cardiac trouble until a short time before death. Autopsy: stomach, duodenum, colon, spleen, and liver bound together by firm adhesions; stomach small and thick walled. Microscopical: shows it to be a simple inflammatory lesion. (Schrumpmagen.) Excellent article.

36. McCrae-Osler, male, age 48. Gastric symptoms for five years; admitted to the hospital with a diagnosis of carcinoma of the stomach; free HCl; lactic acid present; can only take a small amount of nutrition at one time. Operation by Finney. Found a small, contracted stomach with an hour-glass constriction; manual dilatation of the constriction; died four days later. Autopsy: no signs of malignancy or ulceration. Microscopical diagnosis: cirrhosis of the stomach. This is the second case on record in which the diagnosis was made during life and confirmed by microscopical examination.

37. Osler-Henry, male, age 42. Alcoholic history; gastric symptoms for three years; pernicious anæmia. Autopsy: marked decrease in size of stomach; pylorus thickened; cicatrix of old ulcer on lesser curvature; especially noticeable is the atrophy of the mucous membrane and the marked hypertrophy of the muscularis mucosa.

38. Fenwick, male, age 45. Gastric symptoms for eighteen months. Autopsy: linitis plastica macroscopically and microscopically.

39. Fenwick, male, age 50. Gastric symptoms two to three years; cardiac insufficiency marked. Autopsy: linitis plastica.

40. Fenwick, male, age 54. Gastric symptoms for considerable period. Autopsy: linitis plastica.

(In going over these cases of Fenwick's they seem to have a marked likeness to the lesions of severe anæmia.)

41. Jones, male, age 66. Symptoms of anæmia and cardiac insufficiency. Autopsy: benign atrophy of the stomach.

42. Gelham, male, age 45. Gradual progressive gastric symptoms. Autopsy: Microscopical: shows a degeneration and atrophy of the gastric tubules.

43. Marcy-Griffith, male, age 46. Gastric symptoms for five years; alcoholic history; can only take small amounts of food; diarrhœa. Autopsy: stomach very small; lumen contracted; holds 60 c.c.; mucosa smooth; stomach wall 1.5 cm. thick. Microscopical: mucosa very little changed; marked connective-tissue overgrowth in the muscularis; stellate cicatrix in the mucosa.

44. Charles, male, age 73. Gastric symptoms, vomiting and diarrhœa. Autopsy: small, thick-walled, tube-like stomach. Microscopical: linitis plastica, benign. Illustrated.

45. Olliver, female, age 35. Gastric symptoms for two to three years. Autopsy: ascites; stomach small; holds 100 cm.; wall 1.5 cm. thick. Microscopical: linitis plastica, benign.

46. **Sheldon**, male, age 52. Gastric symptoms for fifteen years, gradually increasing; anæmia severe; no free HCl; no tumor; stomach will only hold a very small quantity. Before operation a probable diagnosis of benign stenosis was made; at the operation stomach was found to be greatly diminished in size, the walls thickened, firm, elastic and resistant; walls 1 cm. thick; anterior gastro-enterostomy; patient is well at the present date, May 11, 1911, eight years after operation.

47. **Deaver**, male, age 46. Gastric symptoms for three years; no hematemesis; no melena; cannot retain more than 180 cm. at a time; no free HCl; no tumor. Operation: posterior gastro-enterostomy; stomach much contracted; walls dense and fibrous, resembling in appearance the shape of the small intestine; walls 2.5 cm. thick; died four years later, cause not known. (Personal communication.)

48. **von Eiselberg**, female, age 41. Gastric symptoms for three years; feeling of pressure in stomach; anorexia and frequent vomiting; stomach's contents normal; stomach only held a small amount; pre-operative diagnosis: hour-glass stomach with adhesions. Operation: stomach bound down by adhesions; looked like a long, narrow sac; the surface of the stomach between the adhesions seemed to be covered by a net-work of scars; walls were that of a rigid tube; no ulceration; gastro-enterostomy was technically impossible and gastrostomy could not be performed as patient's consent had not been obtained for the formation of a fistula; eighteen days later a jejunostomy by the Witzel method was performed; patient is well five years after.

49. **Hadden**, female, age 30. Gastric symptoms for ten months; Autopsy: stomach, tube-like, 10 cm. long; walls 1.2 cm. thick; mucous membrane roughened and ulcerated at the œsophageal end, remaining portion smooth and firm. Microscopical: mucosa has disappeared; great thickening of the submucosa; muscularis and serosa normal; no sign of malignancy.

50. **Turner**, male, age 60. Gastric symptoms for one month; died three months later. Autopsy: two inches from the pylorus tight stricture; walls of the stomach greatly thickened and fibrous; ulcer on the anterior wall about the size of twenty-five-cent piece; mucosa traversed by fibrous tracts; numerous peritoneal adhesions. Author states that the extreme thickness was not due to the ulcer but the ulcer was the result of the condition.

51. **Leith** (Albutt's system), case of diffuse cirrhosis of the stomach. Microscopical: benign.

52. **Albutt** (Leith), male, age 40. Ten years before had been treated for ulcer of the stomach. Autopsy: non-malignant cirrhosis of the stomach. Albutt believed that the process arose from the scar of a healed ulcer; judging from the scar the ulcers had been of considerable extent and severity, resulting in a keloid.

53. **Ribera**, female, age 40. Gastric symptoms for five years; pain and vomiting; free fluid in the abdomen; tumor. Pre-operative diag-

nosis: cancer. Operation: total gastrectomy; small contracted stomach with adhesions; portion of abdomen wall resected as it was infiltrated. Microscopical: chronic inflammation with the predominance of connective-tissue element; no epithelial elements; old ulcer; well four years after; non-cancerous. First operative case on record.

54. Halipre-Beaurain, male, age 60. Diagnosis of diabetes; no gastric symptoms; leucoplakial patches in mouth and on lips. Autopsy: stomach small and thick-walled; glands enlarged. Microscopical: linitis plastica, benign: glands benign. This case died of diabetic cachexia. These authors reported two other cases which were cancerous in nature. See Table B.

55. Jonas (Van Orden), female, age 41. Had abdominal cramp from youth; lately pain and vomiting; no hematemesis; anachlorhydria; trace of blood in stools; resistance in the epigastrium; thought to be cancer. X-ray was taken and showed a stomach infantile in type; no stenosis; no peristaltic waves; bismuth passes readily into the small intestine; absence of stenosis speaks against cancer. This is the first reported case in which X-ray has revealed this condition.

56. Boulton, female, age 22. Alcoholic; gastric symptoms for three years and a half; diarrhœa is marked; tumor. Made a diagnosis during life of linitis plastica (1862). On gross examination it appears to be linitis plastica, but as no microscopical examination is given, we cannot accept it. This is the first reported case in which the diagnosis was made during life.

57. Holand, female, age 35. Three years ago noticed an enlargement of abdomen; tumor; indefinite gastric symptoms. Autopsy: dense, fibrous adhesions involving viscera and omentum; small, thick-walled stomach. Microscopical: benign linitis plastica.

58. Derveau, male. Gastric symptoms for one year; pain, distress and vomiting; no hematemesis; anachlorhydria; cachexia; an extensive mass was felt and a pre-operative diagnosis of cancer of the pylorus with extension on the anterior wall and lesser curvature was made. Operation: stomach size of kidney and felt like kidney; numerous adhesions to all the neighboring organs; anterior gastro-entero-stomy made; lumen of stomach greatly reduced; walls very thick. Case improved for a time but died four months later. Microscopical: extreme case of linitis plastica; benign.

59. Philleppen, female, age 36. History was that of ulcer of the stomach; gastric symptoms for eight years; had marked hypochlorhydria; diarrhœa toward the close; died in the hospital after two months' medical care. Autopsy: Macroscopical and microscopical: linitis plastica, benign; no ulceration. Writer thinks it is most often seen in tubercular subjects.

60–61. Viellers reports two cases of typical benign linitis plastica complicated by tuberculosis and states that this tubercular relationship is common in this disease of the stomach.

Krompecher reports on the anatomy, histology, and pathogenesis of nine cases of sclerotic stenosis of the stomach and intestinal tract.

62. Female, age 54. Death the result of a mitral stenosis. At autopsy a marked funnel-shaped stenosing hypertrophy was found; the pylorus was 7 cm. thick; on the surface of the stomach were fibrous patches; there was a similar lesion on sigmoid. The latter growth was the most marked at its mesenteric attachment. Microscopical: mucosa, nothing abnormal; muscularis mucosa, intact, œdematous; submucosa, sclerosis, hypertrophy and œdema with a characteristic obliteration of the capillaries; subserosa, peculiar calcareous deposit; circumscribed telangiectasis in the walls of stomach and sigmoid.

63. Male, age 47. Cause of death: purulent cystitis, pyelonephritis, amyloid degeneration of the kidney. There was an old fibrous pleurisy, fibrous peritonitis, an induration of spleen and pancreas and a marked funnel-shaped stenosing hypertrophy of the pylorus, dilatation of stomach and a circumscribed telangiectasis. Telangiectasis and fibrous patches in rectum. Marked hypertrophy and sclerosis of bladder and ureters. Microscopical: gastro-intestinal tract, bladder, and ureters showed a combination of hypertrophy, sclerosis and œdema with a tendency to the obliteration of the capillaries of submucosa.

64. Female, age 36. Diagnosis: cardiac insufficiency (bicuspid). Autopsy: marked arteriosclerosis, dilatation of heart, induration of lungs and liver, fibrous peritonitis, hypertrophy of pylorus and the small and large intestine, ulcer of rectum. Microscopical: marked necrosis of the atropic mucous membrane of the small intestine, a combination of œdema, hypertrophy and sclerosis of the connective tissue elements, causing a compression of blood vessels which leads to an obliteration or dilatation.

65. Male, age 79. Chronic endocarditis of the mitral and aortic valves, arterio-sclerosis, empyema of lungs; hypertrophy and stenosis of pylorus; small intestine involved. Microscopical: œdema, sclerosis and hyalin degeneration of the thickened pylorus and corresponding lesion in the small intestine.

66. Female, age 64. Arteriosclerosis, secondary endocarditis, venous hyperæmia, œdema, pyloric hypertrophy. Microscopical: mild inflammation of mucous membrane; œdema, sclerosis and hyalin degeneration of the muscularis, submucosa and serosa.

67. Male, age 49. Arteriosclerosis, secondary endocarditis, marked pyloric hypertrophy, venous hyperæmia, œdema, and atrophy of intestine. Microscopical: mild inflammation of mucous membrane, œdema, sclerosis and hyalin degeneration of the muscularis, submucosa and serosa.

68. Male, age 62. Clinical diagnosis: gastric cancer. Autopsy: general arteriosclerosis, hypertrophy of heart; interstitial myocarditis, venous hyperæmia, œdema pylorus; marked hypertrophy with stenosis; intestine œdematous, at places atrophy. Microscopical: mild inflammation of mucous membrane, œdema, sclerosis and hyalin degeneration of the muscularis, submucosa and serosa.

69. Male, age 44. Villous cancer of bladder; fatty degeneration of heart muscle; adhesive pleurisy; œdema of lungs; fibrous perihepatitis; pyloric hypertrophy. Microscopical: marked œdematous involvement of the sclerotic and hypertrophic connective tissue of stomach and small intestine.

The above cases of Krompecher's series show a benign stenosis of the pylorus; with the exception of Case 68 they were all discovered at autopsy.

Cases 62, 65, 66, 67 had non-compensating hearts with arteriosclerosis. Cases 63 and 69 had bilateral adhesive pleuritis, empyema, perihepatitis and heart weakness. Cases 64 and 68 had extensive arteriosclerosis. Ages range from 36, 42, 49, 49, 54, 62, 64, 79—5 men, 3 women.

70. Male, age 22. Died of incarceration and peritonitis. Autopsy: degeneration of heart, œdema of lungs, œdema of small intestine; chronic peritonitis, wax-like plaques on the serosa of the stomach and intestine. These plaques show a combination of hypertrophy, sclerosis and œdema; some of them show calcareous sclerotic tissue. The sclerosis is most marked in the submucosa and many of the vessels are collapsed.

From the study of this case Krompecher pictures the steps: first, a chronic venous œdema caused by cardiac insufficiency, arteriosclerosis, callus pleuritis, chronic empyema, etc., and following on this is an œdema and induration. In the literature the reports, as a rule, are confined to the stomach and do not give the lesions of the other viscera. He concludes that gastro-intestinal sclerostenosis bears a near relation to venous congestion and œdema; third, the pathological process is similar to scleroderma, begins with œdema and ends with sclerosis.

LYLE. The patient, B. B., was transferred from the medical service of Dr. Janeway to the surgical service of Division B, St. Luke's Hospital.

Diagnosis.—Partial volvulus of stomach with abdominal adhesions.

Admitted June 11; transferred to surgical side, July 23, 1907.

History.—Woman, single, aged forty; Swede, occupation, cook.

Family History.—Father had kidney trouble and rheumatism. Three children had rheumatism, two had cardiac complications; third attack two years later, in bed five weeks; last January was in bed three weeks with an attack of rheumatism. This was followed by an otitis media, which lasted four weeks. Has nocturnal dyspnœa, suffers from pain, palpitation, dizziness, and syncope. Menses irregular and painful. No history of syphilis.

Present History.—Five days ago had sharp, cramp-like pains in the left lumbar and inguinal regions, radiating downward and inward into the thigh. These pains persisted for three days, then disappeared, to reappear on the second day after; felt nauseated, but did not vomit. These attacks came at irregular intervals and bore no relation to the taking of food. Complained of tenderness at a point just to the left of umbilicus.

Urination: Some increased frequency, somewhat cloudy; otherwise negative. Bowels constipated, appetite poor.

Physical Examination.—Patient, woman, weight 98 lbs.; large frame; poorly nourished; skin and mucous membranes anæmic; tongue clean.

Pulse: Irregular and of poor force.

Heart: Apex in sixth space, 4½ inches to left; action somewhat irregular. There was a harsh, blowing, systolic murmur heard at the apex; a second one heard over the pulmonic area. Second pulmonic accentuated; right border one inch to the right.

Lungs: Clear.

Abdomen: Tenderness and slight muscular spasm one inch down and to the left of the umbilicus. No mass made out. Liver enlarged. Spleen not felt. Right kidney palpable. Rectal and vaginal examination negative.

Extremities: Superficial glands enlarged.

Blood: Leucocytes, 11,532; polynuclears, 74 per cent.; lymphocytes, 26 per cent.; hæmoglobin, 70 per cent. Urine normal.

Patient was examined in hot bath, and a sense of muscular resistance was experienced in the upper left quadrant.

Tuberculin injected. No reaction.

June 12: Patient still complained of severe attacks of pain in the epigastric region, had several attacks a day—no relation to the taking of food.

June 19: Attacks of pain continued—several every day. At times the pain radiated upward into the left axilla and across the abdomen. The attacks grew more severe.

Stomach analysis, June 4, 1907: Total acidity, 56; free HCl, 20; no lactic acid; no Boas-Oppler bacilli; no blood.

As the condition was steadily growing worse, she was transferred to the surgical side for operation, the diagnosis being gastric adhesions.

Operation by Dr. Lyle, July 27, 1907. On opening the abdominal cavity a mass of adhesions was encountered and the exact relation of the parts could not be made out. On separating the adhesions, it was found that the stomach was half rotated to the left, and the pylorus was firmly fixed by a short, dense, fibrous band to abdominal wall one inch and a quarter to the left of the umbilicus; there was a corresponding twist in the great omentum. The stomach itself was about half the size of a fist, puckered, and scarred. Over the region of the pylorus and lesser curvature the wall was markedly thickened and congested, suggesting a possible old ulcer or a new growth. A portion of tissue was removed for examination. Glands enlarged. It was decided to shorten the gastrohepatic ligament to prevent the recurrence of the rotation, and to do a gastro-enterostomy. During the shortening of the ligament, the patient's condition became serious, so the gastro-enterostomy was abandoned and the abdomen closed. The patient was returned to the ward. From the second day on she made an uninterrupted recovery. She left the hospital on the fifteenth day, apparently cured of all her symptoms.

The examination of the tissue removed showed granulation tissue, young connective tissue with areas of chronic inflammation. Nothing pointing to malignancy. Patient was seen eight months later, when she appeared to be well and strong.

Patient was again admitted to the hospital August 20, 1908.

History.—Since leaving the hospital she has been perfectly well, provided she limits her food in quantity. The quality does not seem to make any difference. Five weeks ago began to vomit half an hour after eating. The ingestion of food causes considerable pain, which pain is referred to the old scar. The patient can take only small quantities of food. Pain is sharp and cramp-like in character and radiates down the left leg to the knee; has gradually grown worse, and is very severe at the present time. Some burning in throat and eructations of gas. Has lost 25 lbs. in 8 months. Has grown quite weak. Occasional attacks of dizziness; no symptoms of loss of cardiac compensation. Stomach contents show a slight increase of total acidity and free HCl on the first examination; the second a loss of acidity and free HCl.

Abdomen: Concave, soft, and relaxed. There is a firm linear scar, three inches long, half way between ensiform and umbilicus. Some tenderness in the epigastric region. No mass made out. Outline of stomach could not be mapped out. Six ounces of water distended the organ and gave considerable distress.

Diagnosis.—Possible gastric adhesions. With the previous history in view, it was thought advisable to place the patient under medical treatment for gastric ulcer before proceeding to operation. Patient put on Lenhartz's regimen. There was no improvement.

Operation September 9, 1908. Dr. Lyle.

On opening the abdominal cavity, a small, shrunken, and scarred stomach was found covered with adhesions—some of these dense, others thin; they extended from the anterior surface to the abdominal wall and from the lesser curvature to the under surface of the liver. The lesser curvature was represented by a dense, scar-like mass, radiating from which were folds of thickened tissue and adhesions. The distance from the pylorus to the œsophageal opening, measured along what remained of the lesser curvature, was less than one-half inch. The stomach was contracted to about the size of a goose egg, and was almost circular in shape. The stomach wall seemed to be twice the normal thickness.

A no-loop posterior gastrojejunostomy was performed; considerable difficulty was experienced, due to the smallness of the stomach and the thickness of its walls. The patient made a prompt and rapid recovery and was out of bed on the thirteenth day.

Since leaving the hospital she has been under careful observation, and is well and strong. Has gained 35 lbs., and worked steadily since leaving the hospital. The stomach contents still show a diminished acidity.

At the first operation the condition was not recognized, and it was thought to be a case of ulcer of the stomach with the formation of numerous perigastric adhesions, accompanied by accidental rotation of the stomach. The walls of the stomach at that time were thickened and scarred. The freeing of the adhesions and shortening of the gastrohepatic ligament gave relief for almost a year.

At the second operation the uniform increased thickness of the walls and the marked diminution of the size of the stomach, plus the scarring, showing that something else than a contraction following a simple ulcer had to be dealt with. In the causation of this case we have a combination of two factors, each of which have been given as a cause of the disease. We have a well-marked history of chronic passive hyperæmia from cardiac insufficiency (the result of repeated attacks of rheumatism), and a strong possibility of multiple peptic ulcers. The chronic condition, plus the irritation set up by the ulcers, would undoubtedly be a sufficient stimulus to start changes in the connective-tissue elements of the stomach, and thus lead to marked general contraction; with the contractions would come of necessity a thickening of the walls, until we find a rigid organ with greatly diminished lumen and thickened walls, as found in this case.

Note.—Since the preparation of this report the patient has had four distinct attacks of toxic erythema, due to the taking of meat. These attacks can be controlled by the addition of some dilute HCl and pepsin, showing that her stomach digestion is below par for digestion of meats.

TABLE B.

Cases Reported as Linitis Plastica which are Malignant in Nature.

1. Weil. T. G., male, age 61. Two months before entering hospital noticed a tumor in pyloric region; tenderness; regurgitating vomiting; died of purulent pleurisy. Cachexia was a very prominent symptom. Autopsy: stomach wall is 2.5 cm. thick; mucosa normal; submucosa was replaced by a hard, dry tissue which furnished no juice on scraping; head of pancreas and prevertebral glands invaded; peritoneum not involved. Microscopical: mucosa a little invaded by new growth; muscularis destroyed; submucosa makes two-thirds of the thickness; considers this a new plastic growth similar to a fusiform sarcoma.

2. Lyonnet, female. Symptoms for ten months. Autopsy: enormous diffuse thickening of the whole stomach; secondary deposits in the pancreas and heart; ascites; enlargement of the glands. Microscopical: malignant linitis plastica.

3. Bezançon, male, age 41. Alcoholic; symptoms for a year; vomit-

ing quarter of an hour after eating; pain. Autopsy: stenosis of the pylorus formed of sclerotic tissue; no ulceration; stomach somewhat dilated. Microscopical: a typical epithelioma (Bezançon). Chronic inflammation without cancer. (Cornil.)

4. Tilger, female, age 35. Progressive gastric symptoms for two years; induration of pylorus; stomach dilated. Autopsy: marked stenosis of the pylorus; stomach walls thick. Microscopical: all coats hypertrophied; submucosa most marked; between connective-tissue there are masses of epithelial cells denoting cancerous degeneration; mucosa shows the lesions of chronic gastritis. (Plates with detailed examination.)

5. Bret-Paviot, female, age 43. Alcoholic; insidious onset beginning four years before; last eighteen months has had attacks of colic and diarrhœa; persistent vomiting; no hematemesis; no melena; stomach tube appeared to stop at the cardia; tumor. Autopsy: ascites; stomach white in color, cylindrical with the calibre of the colon, two-thirds of its extent involved; numerous adhesions; similar lesion in colon; two tumors on ovary, possible cancers or fibro-myomata. Microscopical: all coats show connective-tissue infiltration, the maximum being in the submucosa; epithelial cells are found here and there. Examination of an ulcer in the cardiac region shows it to be non-cancerous. This is classed by Tourlet as benign but it is undoubtedly malignant.

6. Lepiné, cit. by Bret-Paviot, female, age 49. Progressive gastric symptoms for two years; diarrhœa and vomiting at close; no hematemesis; no melena. Autopsy: small, thick-walled, adherent stomach; section is pearly white in color and grates under knife; glands of the lesser curvature involved. Microscopical: mucosa lymphoid hyperplasia; submucosa infiltrated with undulating connective-tissue fibres in the meshes of which are epithelial cells. This is quoted by Tourlet as being benign but is undoubtedly malignant.

7. Pilliet-Sakorraphis, male, age 31. Pain in the right side; loss of appetite; ascites; thought to be a cirrhosis or tubercular peritonitis; patient never vomited; died three years and a half after onset. Autopsy: stomach about the size of the closed fist; walls thick and hard; numerous adhesions; mucosa thickened; no ulceration. Microscopical: all coats of the stomach equally involved; embryonal infiltration at the pylorus; at greater curvature the mucous membrane is thinned; numerous round and fusiform cells present; the muscularis mucosa has disappeared; submucosa connective-tissue, infiltration with fusiform cells; vessels show endoarteritis; the colon presents similar lesions. Tourlet classifies this as a benign case.

8. Petibon, male, age 54. Has had indefinite gastric symptoms for years; symptoms of chronic gastritis for six months; tumor. Autopsy: small, thick-walled stomach; œsophagus involved; glands enlarged. Microscopical: linitis plastica, cancerous.

9. Verhoeghe, male, age 60. Gastric symptoms for more than a year; regurgitation is marked; alcoholic. Autopsy: shrunken, rigid stomach

resembling coil of small intestine. Microscopical: cylindrical epithelioma with connective-tissue infiltration: linitis plastica, malignant.

10. Brissaud (Tourlet), male, age 34. Alcoholic; lues six years previously; gastric symptoms for a year; vomits immediately after taking food; lately vomiting has become incessant; stomach is not dilated; tumor in the region of the pylorus; no hematemesis; no melena. Operation: pylorectomy by Debét. Pre-operative diagnosis: chronic gastritis with fibrous stenosis of the pylorus. Portion removed at operation shows a neoplasm in the form of a cylinder 6 cm. long; consistency of the walls recall a fibroma or myoma. Microscopical: by Monod. This is quoted as benign by Tourlet. Schacher says it is a typical epithelioma. P. 77. Patient well four months after.

11. Vautrin-Hoche, male, age 29. Gastro-enterostomy; two months after operation patient returned, suffering from a vicious circle; entero-enterostomy performed; death the following day. Stomach small, thick walled; retroperitoneal adhesions. Microscopical: diffuse epithelioma appearing in the zone of an old ulcer.

12. Schacher, service of Brissaud, female, age 55. Active gastric symptoms for five months; patient had had pains in the epigastrium for six years but had attributed them to her occupation which necessitated pressing with a heavy iron; constipation is marked; she had a total abdominal hysterectomy performed; both ovaries showed cysts. Operation gave no relief. Autopsy: stomach presents a hard, rigid, annular thickening; numerous adhesions; colon adherent to stomach, gall-bladder invaded by new growth; stomach adherent to posterior abdominal wall; cæcum involved at the base of appendix; sigmoid and rectum also show cancerous invasion. Microscopical: shows it to be a gastric tumor localized in the lesser portion of the stomach with anterior and posterior peritoneal adhesions. Schacher considers this a linitis plastica of cancerous nature. The course of the tumor has terminated in a generalization of the disease showing that the linitis plastica was a malignant cancer of epithelial origin. Excellent article, well illustrated.

13. Weiss (Schacher-Boechel), female, age 50. Gastric symptoms for several years; tumor. Operation: partial gastrectomy. Weiss thought it to be pure linitis plastica. Microscopical examination was made by Hoché. There is some doubt about the diagnosis of linitis plastica as an epithelial infiltration was found at the site of the old ulcer. This appears to be a diffuse infiltration of typical epithelial elements in the sclerotic inflammation of the cicatrix of an old ulcer; possibly this is a cancer developing on an old ulcer(?). This case is reported by Boechel as being well two years and a half after. (Boechel, p. 162, No. 38.)

14. Spillmann (Schacher), male, age 47. Gastric symptoms for one year; stomach not enlarged; no tumor; death from cachexia. Autopsy: lesions of linitis plastica most marked in pyloric region. Microscopical: diffuse neoplastic infiltration of an epithelial type in the sclerotic tissue.

15. Weiss, male, age 32. Died shortly after admission to hospital of

apparent cancer of the stomach; pylorus admitted little finger; antrum occupied by a tumor about the size of half a mandarin; stomach wall hard, pearly white in color; retroperitoneal "callus"; mesenteric and duodenal plaques. This is a case of epithelial linitis plastica type, having its origin in an old ulcer.

16. Gayet-Patel, female, age 44. Gastric symptoms for eight months; no dilatation; no stasis; diffuse tumefaction in the region of the pylorus; free HCl absent. Total gastrectomy by Jaboulay. Stomach movable; pylorus hard and thickened; mottling and cloudiness of peritoneum; in the mucous membrane, near the pylorus, is a small erosion. Microscopical: evidence of connective-tissue in all layers; here and there cells of an epithelial character. Probably inflammation started from a cancerous base. One year later rectum was removed; it showed a recurrence. (Bret-Paviot.)

17. Vautrin, male, age 29. Gastric symptoms; vomiting; no hematemesis; pyloric tumor; partial gastrectomy. Patient died two years and a half after of acute tuberculosis; there were no signs of a recurrence. At the first examination two years and a half before there were no cancerous elements; a later examination showed suspicious cells in the connective tissue stroma indicating an epithelial degeneration. Boechel, p. 95. Schacher says it was linitis plastica of epithelial type. Final conclusion—scirrhous epithelioma of glandular origin.

18. Curtis showed the stomach, ileum and colon as examples of linitis plastica, benign. On account of the protest he went over the sections again and found a small area which was cancerous. (Neurofibromatose carcinomateus.) "There exists in this case a very systemic propagation of the cancer cells following the tracks of the nerves." No clinical symptoms given.

19. Mouriguand, male, age 28. Gastric symptoms for eighteen months; tumor at the pylorus; stasis; free HCl; partial gastrectomy. (Poncet.) Well twenty-two months after. Diagnosis of linitis plastica was made (Paviot); there were signs of an old ulcer. Microscopical: hypertrophy of glandular region; glands non-cancerous; infiltration of submucosa and muscularis by a new production of connective tissue. Paviot considers these cells to be of neoplastic nature.

20. Mouisset-Chalier, male, age 71. Gastric symptoms for two years; pain on pressure; sense of resistance in epigastrium; no hematemesis. Autopsy: small, rigid, tube-like stomach; numerous peritoneal adhesions; cut section pearly white; no ulceration in mucous membrane; no tumor; cancerous mass in liver. Microscopical: linitis plastica, cancerous.

21. Ménard, female, age 53. Gastric symptoms for two years simulating a stenosis of the œsophagus; smooth tumor in the epigastrium; intestinal paresis; cachexial death. Autopsy: cancerous infiltration of the stomach, omentum and mesentery. This does not seem to be a case of linitis plastica but rather a case of carcinoma of the stomach.

22. Farog, male, age 41. Vague gastric symptoms for one year; clinical course that of cancer. Autopsy: cancerous linitis plastica of the stomach;

neoplasm starting in the mucous membrane of the pylorus and extending to the abdominal walls. Patient had a neoplasm in the breast. No diagnosis is given other than that there were nodules in the skin. This looks like a recurrence after a breast tumor and not linitis plastica.

23. LORRAIN, male, age 55. Gives the symptoms of pyloric obstruction. Autopsy: linitis plastica, cancerous.

24. LECENE, male, age 50. Presents cancer of the pylorus with stenosis; stomach intolerant of food; anachlorhydria. Operation: pylorectomy; stomach small, rigid and tube-like. Microscopical: carcinomatous cells found in the mucosa and in the neighboring lymphatic; involvement most marked in submucosa and muscularis.

25. QUENU, male, age 32. Gastric symptoms for four years; transverse mass in the epigastrium. Diagnosis: carcinoma of the pylorus. Operation: partial gastrectomy. Gross findings those of linitis plastica. Microscopical: shows it to be cancerous in nature.

26. QUENU, female, age 28. Gastric symptoms for less than a year; epigastric tumor. Pylorectomy. No adhesions. Gross: had the aspect of scirrhous cancer. Microscopical: linitis plastica, malignant. Died three years and a half after.

27. STRETTON, female, age 56. Symptoms for three months which were supposed to be due to a cancer of the œsophagus. Gastrostomy was done. Stomach was hard, thick walled and contracted; capacity about one and a half ounces. (Leather bottle stomach.) Microscopical: shows it to be a spheroidal cell carcinoma.

28. ROSSI, male, age 50. Clinical diagnosis cirrhosis of the liver. Autopsy: Gross: appearance is that of linitis plastica with adhesions; stomach is small and drawn up under the ribs; perisplenitis and perihepatitis. Microscopical: mucous membrane shows evidence of an old tubercular inflammation in the muscularis mucosa; the submucosa shows a great enlargement due to connective-tissue in which are found some cellular fusiform elements of epithelial nature. He does not consider them cancerous; gland parenchyma not affected; capillaries invaded by epithelial elements similar to those of the gastric wall. This appears to be linitis plastica of a cancerous nature. Note: *possible tubercular influence.*

29. ROSSI, female, age 20. Symptoms for five months; tumor; no free HCl, blood or lactic acid. Operation: partial gastrectomy. Gross: linitis plastica; no ulceration; cylindrical, thick-walled sac; glands enlarged. Died three months later of intestinal obstruction. Microscopical: linitis plastica, cancerous.

30. TESTI-ZACCARIA, male, age 50. Gastric symptoms for ten months; alcoholic; vomiting; had characteristics of cancer. Gross: linitis plastica. Microscopical: scirrhous carcinoma; nature could not be accurately determined. The author has no doubt that this is an epithelial form of a scirrhous cancer.

31. CARDI, female, age 32. Gastric symptoms for two years; vomiting; HCl absent. Microscopical: linitis plastica without adhesions; lesions occupy pyloric half; on surface are white, fibrous plaques. There is a

possibility of old ulcer. Microscopical: high grade of linitis plastica with scirrhous cancer.

32. Cignozzi, male, age 61. Clinical diagnosis: hepatic cirrhosis with ascites; no direct gastric symptoms; intense diarrhœa; ascites and œdema of lower extremities. Autopsy: ascites; thickened posterior wall; waxy looking deposits on parietal peritoneum; thickened gastric wall with nodules; nodule in the lung; heart showed myocarditis with cardiac insufficiency; chronic tuberculosis of right pulmonary apex. Cause of death, acute perforating peritonitis. This seems to be a case of scirrhous cancer having its origin in the glandular elements. Cignozzi classes this case as a primary retroperitoneal endothelioma with secondary nodules in the stomach and left lung.

33. Cignozzi, female, age 38. Gastric symptoms for fifteen years; dilated stomach; tumor in the pyloric region. Operation: Gastro-enterostomy (Triconni); pylorus the seat of an annular tumefaction which extends from the pylorus to the posterior wall and greater curvature. Died eight days later. "Probable linitis plastica of endothelial type. The form of the cells, the arrangement of the alveoli and tubules, the absence of any epithelial elements exclude a cancerous process and point to an endothelial neoplasm."

34. Cackovic, male, age 36. Lung symptoms for two years; gastric symptoms of long standing; stomach held 100 c.c.; no tumor. Operation: jejunostomy. (Wickerhauser.) Gross: typical linitis plastica. Gastrectomy indicated but technically impossible so jejunostomy was done. Died from peritonitis seven days later. Microscopical: showed it to be cancerous.

35. Cackovic, male, age 60. Gastric symptoms for six months; sense of resistance at pylorus; stomach holds 50 c.c. Operation: stomach small, thick walled; presents a tumor about the size of an apple; numerous adhesions. Jejunostomy. Patient died seven days later from hypostatic pneumonia. Diagnosis: linitis plastica, malignant.

The diagnosis in the above two cases was made during life. In reading them over they seem to be nothing more than scirrhous cancers.

36. Scott reports a case non-malignant stenosis of the pylorus and duodenum; the pathological findings make it doubtful whether this case should be admitted.

37. Pollock, female, age 49. Gastric symptoms for two years; sense of resistance in the pyloric region. Autopsy: shrunken stomach, thick walled; thought to be cancer but careful examination shows no ulceration or malignancy; there seemed to be some doubt in Quain's mind so it is placed in the malignant list.

38. Van Leersum-Rolgens, female, age 22. Gastric symptoms for years; anachlorhydria. Operation: marked stenosis of the pyloric region, extending into the duodenum; pyloroplasty failure; three weeks later gastrectomy. Gross: showed specimen of linitis plastica arising from an old ulcer. Microscopical: epithelial elements found; malignant.

39. Folli-Bernardelli, male, age 60. Gastric symptoms for ten

months; no hematemesis. Autopsy: Gross: linitis plastica. Microscopical: linitis plastica, cancerous type; involvement of glands.

40. **Folli-Bernardelli**, male, age 62. No clinical history. Autopsy: Gross: linitis plastica; no ulceration. Microscopical: linitis plastica, cancerous.

41. **Folli-Bernardelli**, male, age 47. Gastric symptoms for one month; vomiting with small traces of blood; tumor in the epigastrium; ascites. Autopsy: very small, thick-walled stomach adherent to diaphragm and pancreas; mucosa pale; no ulceration. Microscopical: submucosa greatly thickened; contained abundant cellular elements; the epithelial cells had coalesced, forming small centres and infiltrating the neighboring tissue; glands enlarged; linitis plastica, cancerous.

42. **Folli-Bernardelli**, male, age 79. No clinical history; complete involvement of the stomach which was shrunken, thick walled and cartilaginous to feel; mucous membrane smooth; no ulceration; glands involved. Microscopical: marked increase in connective-tissue elements with infiltration of epithelial cells. Linitis plastica, cancerous.

43. **Morone**, female, age 46. Gastric symptoms for eighteen months; tumor in the epigastrium; marked anæmia; hypochlorhydria; hematemesis. Pre-operative diagnosis: cancer of the lesser curvature developing on an old ulcer with secondary involvement of the pylorus. Operation by Tasini. Partial resection; linitis plastica of half the stomach; glands not involved. Patient well fourteen months after. Microscopical: linitis plastica (epithelioma).

44. **Rivet**, male, age 52. Gastric symptoms for two months; alcoholic; no hæmatemesis; no melena; no tumor. Autopsy: tuberculosis of the lungs; stomach contracted and adherent. Microscopical: linitis plastica, cancerous. The interest in this case is that there were no symptoms until two months before death.

45. **Danel**, female, age 34. Gastric symptoms for two years; alternating diarrhœa and constipation; no distention; no definite hematemesis or melena; marked cachexia; transverse cylindrical tumor. Diagnosis: epithelioma of the pylorus extending to the greater curvature. Operation: partial gastrectomy (Duret). Patient died three days later of shock. Autopsy: stomach small, shrunken and thick walled; omentum thickened and covered with whitish plaques; glands enlarged; no adhesions. Microscopical: linitis plastica, cancerous.

46. **Duplant**, male, age 73. No clinical symptoms. Autopsy: showed a greatly shrunken stomach covered by a thickened serosa; the thickened pylorus gave the appearance of a neoplasm; it is a diffuse neoplastic infiltration of the stomach with ulceration of the mucous membrane; glands enlarged. From gross examination the diagnosis lies between benign linitis plastica and a diffuse epithelioma. Microscopical: sections were not given at the time of the report.

47. **Marie.** No clinical history; no data as regards autopsy. Statement is made that it is linitis plastica of a cancerous type.

48. Marie. No clinical history. Autopsy: small, hard stomach with a retroperitoneal callus; no visible tumor; small ulcer near the pylorus; linitis plastica, cancerous.

49. Lorrain, male, age 55. In the hospital for a short time with symptoms of stenosis of the pylorus. Autopsy: small, thick walled, contracted stomach. Microscopical: linitis plastica, cancerous.

50. Babes-Mironesca describe a case in which the gross findings somewhat resemble a linitis plastica but the microscopical examination shows it to be a gelatinous carcinoma.

51. Haliprè-Beaurain, male, age 54. Alcoholic; gastric symptoms for eight months; no solid food tolerated; small tumor. Autopsy: stomach shrunken; feels like a rubber cylinder; middle of the transverse colon shows a fibrous ring; fibrous patches on the small intestine; glands enlarged. Microscopical: linitis plastica, cancerous.

52. Haliprè-Beaurain, male, age 72. Rheumatic; no gastric symptoms; diarrhœa. Autopsy: stomach resembles a segment of the small intestine; greater curvature measures 6 cm.; walls very thick and resistant. Microscopical: linitis plastica, malignant There were no gastric symptoms in spite of the advanced pathological condition. The patient died of bronchial pneumonia.

53. Delamare-Brelet, male, age 63. Alcoholic; gastric symptoms for four years; ascites and œdema of the lower extremities; alternating diarrhœa and constipation; the symptoms seem to be those of cirrhosis. Autopsy: ascites; liver small; mass of adhesions involving gall-bladder, greater and lesser omentum, etc.; stomach small, thick walled; holds only 150 cm.; 10 to 15 mm. thick; glands hard and small. Linitis plastica of an epitheliomatous nature.

54. Faroy, female, age 41. A few indefinite gastric symptoms before entering hospital; vomiting and progressive cachexia; death three months and a half after entering. Autopsy: small, contracted, thick-walled stomach; circular infiltration extending from the greater to the lesser curvature and making an hour-glass contraction; small intestine involved; suspicious nodules in the skin; numerous adhesions to the neighboring organs.

55. Cova-Bons, age 64. Died at 70. Symptoms recurred several times. First diagnosis was diffuse carcinoma of the stomach; second, linitis plastica with pyloric stenosis(?). Sense of resistance in the epigastrium; anachlorhydria; lactic acid present; cachexia marked Autopsy: linitis plastica, cancerous.

56. Roussy presents before the Anat. Soc. of Paris four specimens of linitis plastica, in which the cancerous nature is evident from the histological examination. Two are of the generalized form and two of the localized.

Female, age 61. Linitis plastica, generalized. Short time in hospital and died of profound cachexia. No diagnosis was made Stomach small, hard and retracted under the liver; marked thickening of the coats; lesser and greater omentum involved; large and small intestine not involved; no secondary deposits of the viscera; lymphatic glands hard. Microscopical: grayish white; no ulceration. Histological examination shows it to be linitis plastica, cancerous.

57. Male, age 65. Linitis plastica, generalized. Stomach small, thick walled; 2 cm. thick at pylorus; large part of the transverse colon involved, 10 mm. thick; numerous adhesions; no ulceration of mucous membrane; no ascites. Microscopical: linitis plastica, cancerous; perivascular sclerosis marked in the submucosa.

58. Linitis plastica, localized. Cancerous; limited to the pyloric region. Pre-operative diagnosis: stenosis of the pylorus. Operation: gastrostomy. Small, thick-walled stomach; no evident involvement of the peritoneum. Microscopical: linitis plastica, cancerous.

59. Linitis plastica, localized. Limited to the pylorus. Operation: pylorectomy by Temoin of Bourges. Small, thick-walled stomach; pylorus 28 mm. thick; mucous membrane healthy. Microscopical: linitis plastica, cancerous.

60. Lenore-Courcoux described a case under the title of "septicemie cancereuse secondaire" in which the examination of the local lesion in the stomach suggested a linitis plastica of a cancerous type.

BIBLIOGRAPHY.

[1] Allbutt, C.: Cit. by Leith. System of Medicine, p. 467.

[2] Andral: Clinique médicale, t. ii, p. 59.

[3] Andral: Précis d'anatomie pathologique, 1835, t. i.

[4] Ascoli, V.: Sulla linite plastica del Brinton; Osservazioni critiche a proposito di un recente lavaro. Policlinico-Medica, 1st Octobre, 1894.

[5] Babes-Mironescu: Plastische Linitis und Magenkrebs. Ref. Münch. med. Woch., 1907, No. 32, p. 1605.

[6] Baginsky, A.: Über normalen und pathologischen Befund des Lymphgefassendothels kindlichen Darmwand. Zentrb. f. med. Wissensch, 1882, No. 4.

[7] Ballet: Observation de gastrite chronique, avec rétraction de l'estomac, et épaississement énorme des tuniques musculaire et celluleuse. Bull. Soc. anat., de Paris, 1877, p. 644.

[8] Bandein: Hypertrophie considérable de la muqueuse du cardia et de la grande courbure de l'estomac. Bull. Soc. anat., de Paris, 1837, vol. xxxii, p. 245.

[9] Bard: Anatomie générale des tumeurs.

[10] Bard: Archives de physiologie, 1885.

[11] Bennett, H.: Cancerous and Cancroid Growths. London, 1849.

[12] Bensauda et Okingzo: Retrecissement cancereux multiplis de la partee sous-diaphragmateque du tube digestif. Arch. de Med. Exp. et d'Anat. Path., 4 juillet 1906.

[13] Bensaude et Rivet: Les cancers multiplis du tube digestif. Gaz. des Hôpitaux, Sept. 28, 1907.

[14] Bérault: Hypertrophie chronique de l'estomac simulant un cancer. Bull. Soc. anat., 1847, p. 10.

[15] Bernabei: Boll. d. sez. d. cultore d. scienze med. n. r. Accademia d. fisiocritia di Siena., vol. v, 1807.

[16] Bezançon, F.: Rétrécissement cancéreux du pylore (pas de cancer pour Cornil). Bull. Soc. anat., 1892, p. 802.

[17] Boas. Über hypertrophische Pylorus Stenose (stenosirende Gastritis) und deren Behandlung. Archiv. f. Verdauungskrankheiten, 1898, Bd. iv, 47–62 et 368.

[18] Boeckel, J.: De l'ablation de l'estomac. Paris, 1903.

[19] Bouveret, L.: Traité des maladies de l'estomac, Paris, 1893.

[20] Boyer: Hypertrophie de la membrane musculeuse de l'estomac. Bull. Soc. anat., 1848, p. 49.

[21] Brandt: Die Stenose des Pylorus, Inaug. Dis. Erlangen, 1851, S. 33.

[22] Brellet, M.: La linite plastique de Brinton. Gaz. des Hôpitaux, Paris, 1905, p. 1599–1605.

[23] Bret et Paviot: Linite plastique. Revue de méd., 1894, p. 384.

[24] Bricheteau: Cliniques de l'hopital Necker.

[25] Bricheteau: Affection squirreuse de l'œsophagus du pylore, difference entre cette malade et le cancer. Thèse Paris.

[26] Brinton: Diseases of the Stomach, 1864.

[27] Brissaud: Linite Plastique; pylorectomie; guérison, Semaine méd., 1900, p. 415.

[28] Broca: Hypertrophie du pylore. Bull. Soc. anat., 1850, p. 207.

[29] Bruch: Über Magenkrebs und Hypertrophie der Magenhäute in anatomischer oder klinischer Hinsicht. Zeitschrift für ration. Med., 1849, Bd. viii.

[30] Budd: On the Organic Disease and Functional Disorders of the Stomach, London, 1855.

[31] Bullett: Obliteration of the Stomach as a Result of Gastric Ulcer. Duodenostomy. ANN. SURG., Phila., 1907, xiv, p. 30–33.

[32] v. Cackovic, M.: Über totale Verklienerung. (Schrumpfung) des Magens und uber Jejunostomie. Archiv. f. klin. Chir., 1902, p. 409.

[33] Cardi: Sulla linite plastique del Brinton. Policlinico sez. méd., 1896, p. 576.

[34] Carrière: Hypertrophie partielle des parois de l'estomac. Bull. Soc. anat., 1863, p. 163.

[35] Carswell: Path. Anat., London, 1838, Tab. i–ii.

[36] Carter: Diseases of the Stomach. Med. Fortnightly, St. Louis, xix, 61–70, 1901.

[37] Chalvet: Hypertrophie concentrique de l'estomac. Bull. Soc. anat., 1859, p. 68.

[38] Chaput et Pilliet: Linite hypertrophique non cancéreuse. Bull. Soc. anat., 1896, p. 154.

[39] Chaput et Pilliet: Observation clinique, id., p. 22.

[40] Chaput et Oettinger: Présentation de notre malade. Bull. et mém., Soc. de chir., 3 juillet 1901, p. 794.

[41] Chardel: Monographie de dégénération schirrheuse de l'estomac. Paris, 1908.

[42] Charles, J.: An Account of Cirrhosis or Fibroid Infiltration of the Stomach. Dublin Jour. of Med. Sci., 1875, vol. lix, p. 201.

[43] Charrot-Bouchard-Brissaud: Traité de Médecine, Part III.

[44] Chiari: Über Magensyphlei Internat. Beitrag. zur. Wissenschaf Med. (Virchow Festschr.), 1891, ii, p. 297.

[45] Chifoliau et Masson: Linite Plastique. Soc. anat., Paris, 11 Novembre, 1910.

[46] Cignozzi, O.: Dui casi di endothelioma dello stomaco. La Ref. Med., 1905, pp. 17, 18, 19, 20.

[47] Colonna, G.: Le stenosi piloriche non maligne. Gaz. med. di Torino, 1900, li, p. 267.

[48] Cornil: Rapport sur l'observation Carrière. Bull. Soc. anat., 1864, p. 238.

[49] Cornil et Ranvier: Manuel d'histologie pathologique, 1884, t. ii.

[50] Cova, A., et Bons, G.: Contributo allo studio clinico anatomico ed istologico della linite plastica di Brinton. Gazz. d. osp., Milano, 1909, xxx, 569–571.

[51] Coyon et Legros: Les stenoses pyloriques. Revue générale in Gazette des Hôpitaux, 1898, p. 917.

[52] Cruveilhier: Anatomie pathologique, 1835, t. iii, p. 25.

[53] Curtis, F.: Étude sur un cas de linite plastique gastro-intestinale ou péritonito nodulaire sclérogene stenosante. Archiv. de Med. exper. (1908), also Bull. et mem. de la Soc. anat., 1909, No. 1, p. 14.

[54] Curtis, F.: Nouvel examen du cas linite plastique présente dans la seance du 16 janvier 1909. Bull. et mém. Soc. anat. de Paris, 1909, No. 3.

[55] Damaschino: Leçons sur des maladies des voies digestives, 1888, p. 497.

[56] Danel: La linite plastique. localisée. Jour. de Sci. Méd. de Lille, janvier 1904, p. 4904.

[57] Dawosky, S.: Hypertrophie du tissu cellulaire sous-muqueux du pylore chez un enfant de dix semaines. Archiv. générales de méd., 1843, p. 93.

[58] Deaver-Ashurst: Surgery of Upper Abdomen. Phila., 1908, vol. i, p. 234–237.

[59] Debove et Rémond: Traité des maladies de l'estomac, p. 222.

[60] Deguy: Un cas de linite plastique. Bull. Soc. anat., 1896, p. 314.

[61] Delamare-Brelet: Soc. Méd. des Hôpitaux. Feb. 19, 1909. Linite plastique de l'estomac et de la Vesiculæ Billaire. Also Tribune Méd. Paris, 1909, t. xli, p. 166. Bull. et mém. Soc. anat., 1909, lxxxiv, p. 166–169.

[62] D'Espine et Picot: Traité des maladies de l'enfance. Edition de 1900, p. 631.

[63] Doyen: Traité chirurgical des maladies de l'estomac, 1895.

[64] Dubey: Gaz. Hebdomen, 1883, p. 108.

[65] Dubujadoux: Sur une variété de cirrhose encore inédite accompagnant la gastrite chronique avec sclérose sous-muqueuse hypertrophique. Gaz. hebdomadaire de méd. et de chir., 1883, No. 12, p. 198.

[66] Duclos: Tumeur fibro-plastique de la petite courbure de l'estomac. Bull. Soc. anat., 1854, p. 200.

[67] Duplant: Epithelioma diffus de l'estomac ou linite plastique. Soc. nat. de Méd. de Lyon. Lyon Med., 1899, No. 10, p. 337.

[68] Durand-Fardel: Bull. Soc. anat., 1879, p. 305.

[69] Einhorn: Diseases of the Stomach, p. 165.

[70] Einhorn: Atrophy of the Stomach. N. Y. Med. Record, June 11, 1893, p. 650.

[71] Einhorn: Diagnosis and Treatment of Pyloric Stenosis. Med. Record, Jan. 10, 1895.

[72] v. Eiselberg: A Case of Linitis Plastica of the Stomach (Brinton) Cured by Jejunostomy. Surg., Gyn. and Obs., 1908, vol. vii, p. 253-7.

[73] Eppinger: Totale Scirrhus des Magens (Totale Magenschrumpfung). Cit. by v. Cackovic.

[74] Ewald: Chronik der Verdauungskrankheiten, 1893, vol. ii, p. 187.

[75] Faggi: Case of Diffused Suppurative Inflammation of the Stomach. Trans. Path. Soc., London, 1875, vol. xxvi, p. 81.

[76] Farog: Linite plastique cancéreuse. Bull. et mém. de la Soc. anat., 19 Feb., 1909, No. 2.

[77] Fauvel: Bull. Soc. anat., 1858, p. 224.

[78] Fenwick: On Atrophy of the Stomach and the Nervous Affection of the Digestive Organ, London, 1880.

[79] Folli-Bernardelli: Sulla linite plastica del Brinton. Ref. Med., 1902, Nos. 279, 280, 281, 282.

[80] Formad: Chronic Hypertrophic Cirrhosis of the Stomach with Gastric Ulcer and Colloid Change of Mucous Membrane. Jour. Am. Assoc., 1887, p. 599.

[81] Fox, W.: Hypertrophy of the Walls of the Stomach. Reynolds Encyclopedia, 1872.

[82] Fox, W.: The Diseases of the Stomach. London, 1872, p. 209.

[83] Frenoy: Des Faux cancers de l'estomac. Thèse Paris, 1896.

[84] Gabbi, U.: Su di un caso di linite plastica (gastrite del Brinton). Ref. Med., 1893, 6 et 7 Sept., vol. iii, Nos. 56 et 57.

[85] Galliard: Les cirrhosis de l'intestin. Méd. Moderne, Jan., 1897.

[86] Garret, J.: Contribution à l'étude des néoplasmes de l'estomac; du cancer conjonctif sous-muqueux. Thèse de Lyon, 1892.

[87] Garttner: Über den diffusen Scirrhus des Magens und seine Beziehung sur sog. gutartegen Magenverhärtung. Inaug. Dis. Tubingen, 1878. Cit. by v. Sury.

[88] Gayet Patel: Un cas de gastrectomie totale pour linite plastique. Archiv. générales de méd., 1904. No. 13.

[89] Gluge: Atlas der patholog. Anatomie, Jena, 1850, ix. Lieferung

[90] Guichard, O.: Des rétrécissements intrinsèques et non cancéreux du pylore, anatomie pathologique et diagnostic. Thèse Paris, 1874.

[91] Guelliot, O.: Faux cancer du pylore. Union médicale du Nord-Est, 1900, xxiv, p. 261–265.

[92] Habershon: Pathological and Clinical Observations Respecting Morbid Conditions of the Stomach, London, 1857, p. 99.

[93] Habershon: Diseases of the Stomach. London, 1869.

[94] Hadden, W.: A Case of Extreme Contraction of the Stomach. Trans. of Path. Soc., London, 1891.

[95] Halipré-Beaurain: Linite plastique cancéreuse et non cancéreuse. Revue Méd. de Normandie. Rouen, 1906, vol. vii, p. 401–413.

[96] Handley, W.: Cancer of the Breast and its Operative Treatment.

[97] Hanot et Gombault: Étude sur la gastrite chronique avec sclérose sous-muqueuse hypertrophique et rétro-péritonite calleuse. Archiv. générales de physiologie, 1882, t. ix, p. 410.

[98] Hare: Transaction of the Path. Soc. Med., 1853, t. iv, p. 129.

[99] Hartmann: Rapport sur une observation de Mauclaire: Ulcère du pylore formant tumeur. Bull. et mém. Soc. de chir., 1899, p. 481.

[100] Hayem et Lion: Article: Estomac, Traité de médecine et de thérapeutique, 1896, t. iv, p. 462.

[101] Hemmeter: Diseases of the Stomach. Phila., 1897.

[102] Henrot: Transformation fibreuse de la tunique musculaire de l'estomac, d'une partie du petit et du gros intestin. Gaz. des Hôpitaux, 1878, p. 975 et Union médicale et scientifique du Nord-Est, 1878, p. 11.

[103] Herrenschmidt: Linite cancéreuse gastro-duodenale. Bull. Soc. anat., 1908, p. 542.

[104] Hirsch: Freie Vereinigung der Chirurgen, 22 juin, 1896.

[105] Hoché: Étude sur la linite plastique. Rev. de Méd., 1903, pp. 1079–1116.

[106] Holland: Case of Fibrosis of the Stomach and Peritoneum. Med. Press, London, 1889.

[107] Horn: Einiges über Magenscirrhose. Inaug. Dis. Kiel, 1869. Schriften du Universitatkiel. Cit. by v. Sury.

[108] Huchard: Traité des maladies du cœur et de l'aorte, 1899, p. 132.

[109] Huchard: Des faux cancers de l'estomac. Bull. méd., 1894, p. 243.

[110] Hunt, G.: Trans. of the Path. Soc. of London, 1897–98.

[111] Jaboulay: Lyon méd., 1905, p. 396.

[112] Jacobi, A.: Progressive Contraction of the Stomach with Gastric Hypertrophy. N. Y. Med. Record, vol. xvii, 1880, p. 730.

[113] Jonas: Zur Diagnostik der Schrumpfmagens. Wien. med. Woch., 1909, lix, pp. 260–263.

[114] Jones, Hanfield: Path. and Clin. Obs. Respecting Morbid Conditions of the Stomach, London, 1854.

[115] Jones, Hanfield: Diseases of the Stomach, London, 1855, p. 121.

[116] Jonnesco-Grossman: Contribution à l'étude de la linite plastique. Rev. Chir., 1909, pp. 18–32.

[117] Journal des Praticiens, 1897, Nos. 3. La Linite Plastique.

[118] Kahlden: Über chronische sclerosirende Gastritis. Centralbl. f. klin. Med., 16 Avril, 1887, p. 281.

[119] Kammerer, F.: Benign Obstruction of the Pylorus. Tr. Am. Surg. Assn., Phila., 1900, xviii. p. 74–96.

[120] Karewiski: Über einen Fall von Chlorzin Kvergifung nebst Bemerkungen Jejunostomie. Berlin klin. Woch., S. 1896, No. 50.

[121] Kehr: Zur Chirurgie der Gallenblasenkrankheiten. Berlin. klin. Woch., 1893, No. 2, p. 39.

[122] Krompecher, E.: Zur Anatomie, Histologie und Pathogenese der gastrischen und gastro-intestinal Sclerostenose. Zeigler Beitrag, vol. xlix, 1910, 2 Heft., p. 384.

[123] Kussmaul: Über die Behandlung der Magenerweiterung mittelst der Magenpumpe. Deut. Archiv. f. klin. Med., 1869, vi, p. 455.

[124] Labadei-Lagrave et Deguy: Les Pereviscerthes. Arch. Générales de Med., 1898, vol. ii, p. 385.

[125] Landerer: Über angeborene Stenose des Pylorus. Inaug. Dis. Freiburg, 1879. Cit. v. Sury.

[126] Lange, J.: Über stenosirende pylorus hypertrophie Sauglingsalter. Münch. med. Woch., 1901, xlviii, 280–282.

[127] Lebert: Die Krankheiten des Magens, Tubingen, 1878, S. 525.

[128] Lebert: Anatomie pathologique, t. ii, p. 301.

[129] Lecène: Un cas de linite plastique de l'antre pylorique. Bull. et mém. de la Soc. anat., 1908, No. 10, p. 540.

[130] Leith: Cirrhosis of the Stomach, Albutt System of Med., vol. iii, p. 440, London, 1900.

[131] Le Noir-Courcoux: Septicémie cancéreuse Secondaire. La Presse Med., No. 21, 1908. No. 94, p. 757–58.

[132] Lesser: Cirrhosis ventriculi. Inaug. Dis., Berlin, 1876.

[133] Letulle: Un cas de gastrite chronique accompagnée de sclérose sous-muqueuse et péritonéale. (rapport sur une observation pubilee en 1879 par Durand-Fardel). Bull. Soc. anat., 1883, t. lviii, p. 495.

[134] Letulle: Diagnostic du cancer de l'estomac. Presse médicale, 15 juillet, 1896.

[135] Leube: Die krankheiten des Magens und Darm. Handbuch der spec. Pathologie u. Therapie. (Ziemessen), 1876, vol. vii, 2.

[136] Leudet: Hypertrophie simple des parois de l'estomac. Bull. Soc. anat., 1853, t. xxviii, p. 145.

[137] Leudet: Bull. Soc. anat., 1852, p. 128, paragraph 16.

[138] Leuk: Untersuchungen sur pathologeschen Anatomie des Menschlichen Magens., Zeitsch. f. klin. Med., Band xxxvii, p. 296.

[139] Lieutaud, J.: Historia anatomico-medica, Paris (ed. Portal), 1767.

[140] Lieutaud, J.: Synopsis of the Universal Practice of Medicine, Trans. by Atlee, Philadelphia, 1816.

[141] Luton: Dictionnaire de méd. et de chirurgie pratiques, t. xxiv, p. 150; t. xiv, p. 201 et 270.

[142] Lorrain: Linite plastique cancéreuse. Bull. et mém. de la Soc. anat., 1909, No. 1, p. 43.

[143] Lyonnet: Linites cancéreuses, ganglions de Troisier, ascite chyleuse, généralisation au cœur. Lyon méd., 28 mars, 1897, p. 453.

[144] Macquet: Rapport sur l'observation de Boyer. Bull Soc. anat., 1848, p. 49.

[145] Maier: Beiträge zur angeborenen Syphilis Stenose, Virchow's Archiv., 1895, cii, S. 413.

[146] Maranger, O.: Contribution à l'étude de l'atrophie de l'estomac. Thèse Nancy, 1882.

[147] Marchant-Gérard: Rapport sur une observation de M. Demoulin; Rétrécissement inflammatoire du cæcum. Bull. et mém. Soc. de Chirurgie, 1899, p. 651.

[148] Marchant, Gérard et Demoulin: Sur les tumeurs et rétrécissements inflammatoires de la région pylorique de l'estomac et du segment iléocæcal de l'intestin. Revue de gynécologie et de chirurgie abdominale, 1899, p. 804.

[149] Marcy et Griffith: On Muscular Hypertrophy of the Stomach. Am. Jour. of Med. Sci., 1884.

[150] Marie, R.: Linite plastique. Bull. et mém. de la Soc. anat., 1908, p. 535.

[151] Marignac de: Rétrécissement par hypertrophie des tuniques cellulaires et musculaires du rectum et du côlon transverse. Epaississement analogue de l'estomac. Bull. Soc. anat., 1877, p. 519.

[152] Martin, C. F.: Modern Medicine, Osler, 1908, vol. iv, p. 311-319.

[153] Mathieu, A.: Traité des maladies de l'estomac et de l'intestin, 1901, p. 713.

[154] Mathieu, A.: In Traité de medecine. Charçot, Bouchard, Brissaud, t. iii.

[155] McCrae: Cirrhosis of the Stomach. Johns Hopkins Bull., Jan., 1901, p. 21.

[156] Mènard: Infiltration cancéreuse totale de l'estomac des epiploons et du mesentera (linite cancéreuse). Bull. et mém. de la Soc. anat., 1909, No. 1, p. 23.

[157] Meinel, H.: Untersuchungen über die sogenannte gutarlege Pylorus Hypertrophie und Scirrhus des Magen. Ziegler's Beitrag., 1902, vol. xxxi, p. 479.

[158] Mikulicz u. Kausch: Über Magen carcinoma. Handbuch des Praktischen Chirurgie. von Bergman, von Bruns u. von Mikulicz, vol. iii.

[159] Monard: Jour. Am. Med. Soc., 1902.

[160] Monneret: Affection organique de l'estomac, du foie et du péritoine. Gaz. des Hôpitaux, 1841, p. 469.

[161] Monprofit: Gastrectomie et gastro entérostomie. Bull. de la Soc. de Chir., mars 1898, p. 282.

[162] Moorhead: Combined Cardiac and Pyloric Stenosis. The Practitioner, June, 1911, vol. lxxxvi, p. 831.

[163] Morone: Contribution à l'étude de la linite plastique basée sur une observation clinique. La Reforma. Med., 1908, Nos. 21, 22, 23.

[164] Mouisset-Chalier: Linite gastrique compliques de cancer secondaire du Foie. Lyon Méd., 1909, p. 1004.

[165] Moulin, M.: Lancet, June, 1907.

[166] Mouriquand: La linite plastique du pylore. Lyon Méd., 1907, p. 473.

[167] Müller, J.: Demonstration eines Falles von Schrumpfmagen. Sitzungsbericht der Physio-Medic. Gesellschaft, Würburg, 1902, p. 11. Cit. by v. Sury.

[168] Nauwerck: Ein Fall von hypertrophischer Stenose des Pylorus mit Hochgradiger Magenerweiterung. Deutsch. Archiv. f. klin. Medicin, 1878, xxi, S. 574.

[169] Nicoll: Congenital Hypertrophic Stenosis of Pylorus; with an Account of a Case Successfully Treated by Operation. British Med. Jour., Sept. 1, 1900.

[170] Nothnagel: Cirrotische Verkleinerung des Magens und Schwund der Labdrüsen. Deutsch. Archiv. f. klin. Medicin, Bd. 24, 1879, p. 352.

[171] Oehler: Ein Fall von totaler Magenschrumpfung. Inaug. Dis. Leipzig, 1905. Cit. by v. Sury.

[172] Oettinger: De la stenose hypertrophique du pylore (linite plastique à localisation pyloruque; maladie fibroid du pylore; gastrite hypertrophique stenosante). La Semain Méd., No. 19, p. 153, 1902.

[173] Oliver: Case of Fibroid Induration of the Stomach with Chronic Peritonitis and Ascites. Edinburgh Med. Jour., March, 1891.

[174] Olivier et Halipré: Gastrite scléreuse hypertrophique de nature cancéreuse (linite plastique de Brinton). Normandie méd., 1 avril, 1896.

[175] Orth, J.: Präkarzinomatose Krankheiten und kunstliche Krebs. (Zeitsch. f. Krebsfirschung.), Bd. x, p. 42.

[176] Osler, Henry: Atrophy of the Stomach with the Clinical Features of Progressive Anæmia. Amer. Jour. Med. Sci., xc, 1886, p. 498.

[177] Pedrazzini, F.: Gastrite ipertrofica sottomucosa (linite plastica di Brinton). Gaz. med. lomb., Milano, 1898, lvii, p. 65.

[178] Petibon: Contribution à l'étude de la gastrite scléreuse hypertrophique; ses rapports avec le cancer. Thèse de Paris, 1895, decembre.

[179] Pilliet: Cas de sclérose sous-muqueuse avec hypertrophie musculaire de la portion pylorique de l'estomac. Bull. Soc. anat., 1889, p. 538.

[180] Pilliet et Sakorraphos: Gastrite sous-muqueuse hypertrophique avec rétro-péritonite calleuse. Bull. Soc. anat., 1892, p. 288.

[181] Pilliet: Observation d'érosion avec cirrhose gastrique. Bull. Soc. anat., 1891, p. 703.

[182] Pohl, J.: Handb. d. path. Anat., 1804, vol. ii.

[183] Pollock: Chronic Thickening of the Stomach and Omentum, Somewhat Resembling Malignant Disease. Trans. of Path. Soc., London, 1853, vol. iv, p. 129.

[184] Poncet-Leriche: Bull. Acad. Med., 1905, p. 53.

[185] Quain: Trans. of the Path. Soc. of London, 1870, xxi, p. 168.

[186] Quenu: Deux cas de pylorectomie pour linite plastique. de la dilatation de l'œsophagus à la suite d'une gastrectomie presque totale. Bull. et mém. de la Soc. Chir., Paris, 1906, No. 27, pp. 731–40.

[187] Rakowak, L.: Ein Fall von Gastritis Submucosa. Wiener Med. Presse, 1874, No. 25.

[188] Ramoino-Morgagni: Le cancer infiltré de l'estomac simulant la linite plastique, janvier, 1899. Résumé in Revue genérale de pathologie interne, 1899, 20 avril, p. 115.

[189] Rendu: Leçons de clinique médicale, 1890, t. ii, p. 10.

[190] Ribera, J.: Revesta de Medecin a. y. Cirugia. May and June, 1905, Nos. 602–604. Also Boechel observation, xxviii.

[191] Riegel: Cirrhosis Ventriculi. Diseases of the Stomach. Nothnagel's Encyclopedia, American Ed., p. 497.

[192] Rivet: La Linite Plastique. La Clinique. Paris, vol. v, 1910, pp. 193–7.

[193] Rivet: Linite cancéreuse avec retro-péritonite calleuse et métastasis multiplis. Soc. anat., Paris, 1905.

[194] Robin, Ch.: Clinique de Trousseau, t. iii, p. 74, edit. 1873.

[195] Robin, A.: Traité des maladies de l'estomac, 1901.

[196] Robson (Mayo): Keen's Surgery, vol. iii, p. 825.

[197] Rokitansky: Lehrbuch der pathologischen Anatomie, 1861.

[198] Rosenheim: Société de médecine berlinoise, séance du 11 juillet, 1894. Cit. by Tourlet.

[199] Rossi: Linite plastica e carcinoma infiltrato dello-stomaco. La Clin. Med., 1905.

[200] Rossoni: Un caso d'inflammazione cirrotica dello-stomaco con atrofia glandolare. Lo Sperimentale, 1883, pp. 500–511.

[201] Roussy, G.: Quatre cas de linite plastique de Brinton. Bull. de l'Assn. Français pour l'étude cancer. Vol. iii, Nos. 8, 9, pp. 455–461, Dec., 1910.

[202] Roux: Linite plastique san néoplasme. Rev. Méd. Sci., 1905, No. 1, p. 53.

[203] Roux, J. Ch.: La Linite Plastique: Manuel des maladies du tube digestif. Debove, Archard et Castaigne. Vol. i, p. 707, Paris, 1907.

[204] Salse: Hypertrophie de l'estomac et du côlon transverse. Bull. Soc. anat., 1844, p. 79.

[205] Sandifort: Obs. Anat. Path., vol. iii, p. 11.

[206] Sansoni, L.: Sul morbo di Brinton (Linite plastica, cirrosi dello-stomaco). Torino, 1894, Rosenberg et Sellier, 30 p. 2 pl. in. 8.

[207] Schacher: Une observation du prétendue linite plastique. Paris Thèse, 1905, No. 297.

[208] Schmidt: Atrophie généralisée. Cirrhose de l'estomac avec disparition des glandes à pepsine. Revue médicale de l'Est, 1881, 15 avril, et Mémoires de la Soc. de méd. de Nancy, 1881.

[209] Schnetter: Deutsch. Archiv. f. klin. Med., Bd. xxxiv, S. 632.

[210] Schoch: Über hypertrophische Stenose des Pylorus. Inaug. Dis. Zurich, 1857.

[211] Schwartz: Linite probable, du petit cul-de-sac de l'estomac. Bull. et Mém. Soc. de chir., 27 juillet, 1898, p. 814.

[212] Scott, N. S.: Non-malignant Stenosis of the Pylorus and Duodenum. Cleveland J. M., 1897, ii, 1–12.

[213] Sheldon: Cirrhosis of Stomach. ANN. OF SURG., vol. xxxix, 1904, p. 341.

[214] Sheldon: A Further Report on a Case of Cirrhosis of Stomach. Ann. of Surg., 1906, vol. xliv, p. 666.

[215] Siegheim: Über Syphilis des Magens. Deutsch. med. Woch., vol. xxxvii, No. 4, Jan. 26, 1911.

[216] Smith, J. W. F.: Cirrhosis or Fibroid Degeneration of the Stomach. Edinborough Med. Jour., vol. xviii, Part I, p. 521.

[217] Snellen: Sclérose de l'estomac, article de la Lancette Neerlandaise, reproduit par le Canstatt Jahrberisch, 1856, iii, S. 302 (in Thèse Garret).

[218] Soupault, M.: Traité des maladies des l'estomac. Paris, 1906, pp. 491-497.

[219] Stretton: Leather Bottle Stomach. Lancet, 1909, pp. 464-465.

[220] v. Sury, K.: Beiträge zur kenntnis der totalen, einfach entzundlichen Magenschrumpfung u. der fibrösen Polyserosthes (Zuckerguss). Arch. f. Verdauungsk., 1907, vol. xiii.

[221] Teissier: Pseudo-cancers de l'estomac. Lyon médical, 18 avril, 1886, p. 525.

[222] Terrier: Néoplasme inflammatoire de la petite courbure de l'estomac, adherent au lobe gauche du foie et à la paroi abdominale antérieure, pris pour un carcinome. Laparotomie exploratrice palliative. Guérison definitive de la malade. Soc. de chir., 16 mai, 1894, p. 424.

[223] Terrier et Hartmann: Chirurgie de l'estomac, 1889, Paris, G. Steinheil.

[224] Testi-Zaccaria: Sulla natura dello linite plastica. Riv. Crit. de Clin. Med., 1905, p. 601.

[225] Tilger: Über die stenosirende Pylorushypertrophie. Virchow's Archiv., 1893, Bd. cxxxii.

[226] Tourlet: La Linite Plastique. Thèse de Paris, 1902.

[227] Trousseau: Article (gastrite chronique) in: cliniques, édition de 1873, t. iii, p. 74.

[228] Tuffier: Rapport sur une observation de M. Demoulin sur les tumeurs inflammatoires du tube digestif. Bull. et Mém. Soc. de chir., 1899, p. 833.

[229] Tuffier: Traitément chirurgical des rétrécissements du pylore. Pressé médicale, 9 fevrier, 1898.

[230] Turner, F.: Fibrous Contraction with Hour Glass Stricture of Stomach. Trans. Path. Soc., London, 1887.

[231] Van Leersum-Rotgans, J.: Extirpatie der gehulemang. Œsophago-duodenostomie. Endogastritis obliterans. Deut. med. Woch. I. B. D. 67.

[232] Vautrin: Présentation d'un néoplasme fibreux de l'estomac. Soc. de méd. de Nancy, séances des 26 déc., 1900, et 9 janvier, 1901.

[233] Vautrin-Hoche: Considerations sur linite plastique. La Presse Méd., 1903, p. 477.

[234] Verhoeghe, D.: Note sur un cas de linite plastique Echo med du Nord. Lille, 1898, ii, 449-454.

[235] Viti, A.: Contribuzione allo studio anatomo-pathologico della cirrosi gastrica. Boll. della Soc. tra il culori di Sc méd., v, 1887, resumée in Revue des sc. méd. de Hayem. T. xxxi, p. 543.

[236] Voigtel, F. G.: Handbuch der pathologischen Anatomie. Halle 1804–5.

[237] Weil et Péhu: Les sténoses pyloriques chez le nouveau-né et le nourrison. Revue générale in Gazette des Hôpitaux, 1901, Nos. 112 et 115.

[238] Weil et Destot: Observation publiée à la Société des Sciences médicales de Lyon, janvier, 1890, reproduite dans la Thèse de Garret.

[239] Welch, W.: Pepper's System of Medicine, vol. ii, pp. 611–15, Ed. 1885.

[240] Welch, W.: Johns Hopkins Bull., 1893, vol. iv, p. 98.

[241] Wilks: Malignant Fibroid Diseases of the Stomach. Trans. Path. Soc. of London, 1861–62, vol. xiii, p. 83.

[242] Ziegler: Lehrbuch der speciellen patholog. Anatomie, Jena, 1890, S. 506.

EXTENSIVE REMOVALS OF INTESTINE.

REPORT OF A CASE OF RECOVERY AFTER RESECTION OF TEN FEET EIGHT INCHES OF THE ILEUM.

BY J. DAWSON WHITALL, M.D.,
OF PHILADELPHIA.

Da Costa says ("Modern Surgery," 801) that the removal of more than six and two-thirds feet of gut will produce nutritional disturbances in an adult; that a child tolerates relatively larger amounts resected than an adult. Dressman reported 26 cases in which more than 3 feet 3 inches were removed, while Alexander Blaney (*Brit. Med. Journal,* Nov. 16, 1901) adds seven cases from literature and says that in nine of the 33 cases death occurred soon after operation. The late Nicholas Senn claimed that a third of the intestine was the extreme limit to be excised without inanition following. Roswell Park (*Buffalo Med. Journal,* Apr., 1903) reports the following resections in which over 6 feet 6 inches of intestine were removed, to which I have added the case herein reported.

Operator	Amount Removed	Result
(1) Koeberle	6 ft. 10 in.	Recovered.
(2) Kocher	6 ft. 11 in.	Recovered.
(3) Dressman	7 ft. 2 in.	Recovered.
(4) Shepherd	7 ft. 9 in.	Recovered.
(5) Kukula	7 ft. 9 in.	Recovered.
(6) Harris	7 ft. 10 in.	Recovered.
(7) Hayes	8 ft. 4½ in.	Recovered.
(8) Peck	8 ft. 5½ in.	Recovered.
(9) Lawers	8 ft. 9 in.	Recovered.
(10) Roswell Park	8 ft. 9 in.	Recovered.
(11) Payr	9 ft. 0½ in.	Recovered.
(12) Maydl	9 ft. 4 in.	Died three weeks later.
(13) Fantino	10 ft. 4 in.	Recovery.
(14) Monprofit	10 ft. 4 in.	Recovery.
(15) J. D. Whitall	10 ft. 8 in.	Recovery.
(16) Ruggi	11 ft. 0 in.	Recovery.
(17) Von Eiselsberg	11 ft. 8 in.	Died 25th day.
(18) Obalinski	12 ft. 2 in.	Died.

Several elements enter into the prognosis of these cases:

1. *The amount of gut left after the resection is variable,* as the entire bowel may vary from 15 feet 6 inches to 31 feet 10 inches (Treves). The length of the jejunum is about 8 feet or two-fifths of the small bowel; the ileum about 12 feet or three-fifths of the small intestine; the colon about 5 feet.

2. *The location of the portion removed;* the nearer the resection is done to the stomach the more serious the outcome, the most dangerous in order being duodenum, jejunum, ileum and lastly colon.

3. *Whether there has been fecal contamination of the peritoneum;* cases of course that have a rupture of the bowel and fecal extravasation have less chance of recovery because of the resulting septic peritonitis.

4. *Age and physical condition of the patient* has a great deal to do with the convalescence; the old bearing resection badly, while the reverse is true in the young. Patients who are suffering from malignant disease (sarcoma or carcinoma), who are tuberculous, who are generally "run down" have less chance of recovery.

AUTHOR'S CASE.—M. G., female, married, white, aged twenty-three years. About one year ago was confined, labor normal, but had a portion of the placenta retained, which later caused a pronounced sepsis. After a rather stormy convalescence (following a curettement) she finally recovered, but always complained of pain at the brim of the pelvis on the left side. This pain was often agonizing, causing her to faint several times. She last saw her menses four months ago, and considered herself normally pregnant. Symptoms of a detached placenta intervened, but she ran no temperature. On July 10, 1911, she had a convulsion (had had albumin and casts in the urine for some time) and was admitted to the Northwestern General Hospital. She was hurriedly prepared for a curettement by another physician. The placenta was immediately over the os uteri and came away easily, while portions of a macerated fœtus (four months) were gradually removed. Then a portion of tissue was grasped and pulled down, when it was seen to be bowel.

Up to this time I had not seen the patient; she had been under ether two hours, but was in fairly good condition. The abdomen was hastily scrubbed up. A four inch incision was made in the median line and the uterus exposed; the gut was seen protruding from a perforation on the left anterior portion of the fundus uteri. The bowel was gently withdrawn from the uterus; it was then seen that the mesentery supplying that portion of the gut had been entirely stripped of its connection with the bowel. There was little if any bleeding from the mesentery (the vessels having retracted and clotted). The bowel was not torn or opened at any point. All the intestine that had no mesentery was resected; both ends were ligated, stumps touched with carbolic acid then alcohol; the ends invaginated with a purse-string suture. A lateral entero-enterostomy was then done. The torn mesentery was then whipped over and over with a continuous No. 3 chromic gut suture for its entire length. The distal end was about five inches from the cæcum. The hole in the uterus was then closed with a mattress suture. The abdomen was closed in layers.

The belly was filled with a quart of hot saline solution, while drainage consisting of a rubber tube was placed in the lower angle of the wound to the anastomosis; four pieces of plain gauze (two to the cul-de-sac and one to each side). Sterile dressings were applied. Time of operation was 1½ hours, making a total of 3½ hours under ether. During this time she was given 1/30 gr. strychnine sulphate twice, and was very slighty shocked. Within fifteen minutes after she was put to bed she had reacted and was out of ether.

The specimen of gut removed was then measured in the presence of the physicians present and was found to be 10 ft. 8 inches.

The patient was placed on saline solution, after the method of Murphy, and given morphine sulphate gr. ¼. She had surprisingly little discomfort during her entire convalescence. The drainage was profuse and the wound had to be dressed daily. The Murphy treatment was discontinued after 48 hours. On the fourth day a triplex enema was given with very good result. For several days after, patient moved the bowels normally and passed a large amount of gas. Medication consisted of strychnine sulphate, gr. 1/30 t.i.d. Nourishment was given every two hours —albumin water and broths for the first week, then soft diet, and, after the nineteenth day, general diet. The drainage tube was gradually removed each day and a portion cut off, as was the gauze packing. All drainage was out by the eighteenth day, the wound cavity containing nothing but serum. The other portion of the incision healed by first intention. Patient left the hospital on the twenty-sixth day. Her bowels appeared normal in every respect. After being home for two days, as a result of her moving around too freely, she developed a phlebitis of the right femoral vein. Under rest, elevation, and the use of an ichthyol dressing (50 per cent.) the condition cleared up in ten days.

Granting that the ileum is about 12 feet, the patient should have about 1 foot 6 inches left of this portion of the small bowel. The writer realizes that even yet nutritional disturbances may follow, but up to the present time her physical condition is entirely satisfactory.

This case is reported with the desire that other seemingly hopeless cases of intestinal injury (or new growth) may have the benefit of extensive resection.

RIGHT INGUINAL HERNIA FOLLOWING APPENDECTOMY.

BY JOSEPH PIERRE HOGUET, M.D.,

OF NEW YORK.

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For some time past the importance of preserving the nerves of the abdominal wall in doing laparotomies has been more or less realized, but it is doubtful if many know what the result of the destruction of one or more of these nerves means. This general subject has been gone over before in a previous paper published by the author in the ANNALS OF SURGERY for August, 1911. It was while working on that subject that the frequency of right inguinal hernia, after the apparent injury to one of the abdominal nerves in doing an appendectomy, became apparent. In order to establish more exactly the frequency of this condition, the records of St. Luke's Hospital, of New York City, were gone through and the history and physical examination of the last 190 cases of right inguinal hernia were looked through, in order to find out whether the patient had had an antecedent appendectomy. All congenital and double acquired hernias were naturally omitted.

For the privilege of using these records and reporting these cases, the author is indebted to Drs. C. L. Gibson and Robert Abbe, on whose services these patients were admitted to the hospital.

Altogether eight cases of right inguinal hernia were found in which there had been a history of an antecedent appendectomy, the time of appearance of the hernia varying, the shortest one being two weeks after leaving the hospital and the longest, four years. The greater proportion occurred in those cases in which the appendix wound had been drained, and in which, of necessity, it was larger, with a greater chance of nerve injury, whether by directly cutting the nerve in doing the laparotomy or by the pressure on the latter by a drainage tube.

One case of special interest may be mentioned here, that of a young man, who was operated upon for acute appendicitis, the wound being drained. He stayed in the hospital six weeks, and was readmitted six years afterward with the history that his wound had given him no trouble until two weeks before admission, when it became swollen and tender. The old wound was then incised on two separate occasions, and considerable pus found between the layers of the abdominal wall. This healed up in about four weeks, and he left the hospital only to be readmitted in 15 days with a right inguinal hernia which he said he had noticed for the first time two or three days after his last leaving the hospital.

The reason for the appearance of these hernias is quite obvious. Practically all of the muscles in the region of the inguinal canal receive their nerve supply from the first lumbar nerve through its iliohypogastric and ilio-inguinal branches, the former supplying considerably more muscle, especially the lower part of the internal oblique and transversalis, commonly known as the conjoined tendon. The ilio-inguinal nerve is practically out of reach of the surgeon, emerging as it does just below Poupart's ligament about one and a half inches internal to and below the anterior superior spine of the ilium. The iliohypogastric branch, however, is generally more than one inch above the preceding, and runs downward and inward between the internal oblique and transversalis muscles. It crosses a line drawn from the umbilicus to the anterior superior spine almost two inches above the latter. Although the ordinary McBurney incision would run roughly parallel to the nerve, it can easily be seen in what danger the latter is, even though the fibres of the internal oblique are separated and not cut. The twelfth dorsal nerve takes the same course more than one inch higher up and is generally double.

Of course many cases are seen in which there is not only a right inguinal hernia but also a hernia in the appendix scar. An example is given in one of the cases cited below. This naturally ensues from the cutting of the nerve, so that the muscle on the inner part of the wound being paralyzed is so flaccid that it not only admits the passage of a ventral hernia, but also causes a certain amount of retraction of the internal oblique and transversalis from Poupart's ligament, so that an inguinal hernia ensues.

The more essential points in the histories of the eight cases found in the hospital records are given below.

CASE I.—Appendectomy through McBurney incision for acute appendicitis with spreading peritonitis. Wound drained, patient left hospital in five weeks. Readmitted ten months from date of first operation with a hernia in the appendix scar, and a right inguinal hernia, the latter having first been noticed one month before. Left inguinal region normal.

CASE II.—Appendectomy through McBurney incision for acute appendicitis with general peritonitis, counterincision in loin. Both wounds drained. Patient left hospital cured in six weeks. Readmitted three years and two months from date of first operation with a right inguinal hernia, which had appeared thirteen months previously. Left inguinal region normal.

CASE III.—Appendectomy through McBurney incision for chronic appendicitis. Wound healed *per primam,* patient left the hospital in ten days. Readmitted in one month with a right inguinal hernia which had first appeared two weeks before. Left side normal.

CASE IV.—Appendectomy through McBurney incision for acute appendicitis. Wound drained, patient left hospital in four weeks. Readmitted in one month with a right inguinal hernia first noticed two weeks before. Left side normal.

CASE V.—Appendectomy through McBurney incision for chronic appendicitis, in hospital ten days. Readmitted four years from date of first operation with a right inguinal hernia which had existed one year. Left side normal.

CASE VI.—Appendectomy for acute appendicitis. Wound drained, patient left hospital in six weeks. Readmitted in four years, with a right inguinal hernia that had existed six months. Left side normal.

Case VII.—Appendectomy for chronic appendicitis. McBurney incision. Left hospital in ten days. Readmitted in eighteen months with a right inguinal hernia that had existed two months. Left side normal.

Case VIII.—The case of abscess in old appendix scar mentioned above.

Several other cases of this kind have lately been observed. One was a right direct hernia which had appeared one month after an appendectomy. This man had never had any trouble in the inguinal region before, and when seen the left side was normal. Another case was that of a young man who had had an appendectomy through a Kammerer incision, and noticed a swelling in the right groin three months after the operation.

Of course, eight cases out of 190 is not a large percentage, but the claim can justly be made that these are very conservative figures. It is very possible that there have been others out of the 190 who had trouble and who did not come back to St. Luke's Hospital to be operated upon for the hernia, or the fact of the antecedent appendectomy might have been overlooked by the historian. Yet, to the author's mind, this is a condition that really exists and, although recognized, enough attention has not been paid to it.

FRACTURE-DISLOCATION OF THE ATLAS.

BY F. L. CARSON, M.D.,
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Reports of cases recovering after fracture-dislocations of the atlas are not infrequent, and my excuse in reporting this case is because recovery followed what was apparently a secondary myelitis, from which recovery seemed impossible, with the patient in such a desperate condition that operation seemed out of the question, and palliative measures alone were used.

Case I.—W. T., aged twenty-nine, while riding on a roller coaster, standing erect, was thrown forcibly while at about the height of twelve feet, striking on his forehead, producing extreme extension. He was immediately stunned but not unconscious, was picked up, and with a little assistance went home. He complained of severe pain and stiffness of the neck, associated with swelling in the region below the right mastoid.

The patient was seen by various physicians before a correct diagnosis was made, after which a plaster jacket was applied, with relief from the pain and stiffness, from which he had suffered since the accident.

About two months after the accident the patient resumed his occupation as a street car motorman. He continued in this capacity without much inconvenience, until one cold, stormy night his car struck a drift, giving him a severe jolt and causing a return of the pain. His physician again applied the plaster jacket but this time without relief, and finally he was brought home, at which time I saw him in consultation, about four months after the injury.

Examination.—Well nourished male. His head turned to the left. Involuntary contractures of all four limbs. Breathing entirely diaphragmatic. Complete analgesia below the clavicle. Incontinence of faeces and retention of urine. Hands and feet flexed. Marked prominence of posterior part of neck just below the mastoid. Bulging in the pharynx.

Patient was placed on his back and a collar around the chin and occiput applied, from which an 8-pound weight, over a pulley, was suspended. The head of the bed was raised about four inches, to overcome the traction. The pain at once became less severe, the paralysis after several weeks began to recede, first improving in the feet, then the legs, then the body, later the arms, and last of all the forearms. After allowing the patient to get out of bed an ambulatory extension apparatus was applied and worn for several months.

At the present time after nearly two years since the injury, the hands present evidence of paralysis. The fingers are clumsy, the interossei are atrophied, and the strength of the hands is very much impaired. The neck is much less rigid, there is no pain on attempts at motion. Swallowing food, at first difficult, is now easy. The patient at the present time is doing some manual labor, and is in fine general health.

The accompanying skiagram, while rather poor, shows the displacement to be marked. The recovery in this case, after a secondary myelitis, is unusual, and I believed worth reporting.

Fig. 1.

[illegible]

MUSCLE GRAFTING FOR GUNSHOT WOUND OF THE SHOULDER.

BY BENJAMIN BRABSON CATES, M.D.,
OF KNOXVILLE, TENN.

If the end results of traumatic surgery are not always brilliant, the surgeon may console himself with the thought that, even if the cosmetic effect may not be all that is desired, the functional utility of the limb is restored ofttimes to a surprising degree even in apparently hopeless cases, so that in the face of discouraging prospects it is often well worth while to adopt an expectant plan of treatment. Because in so doing, as time goes on, some plan may suggest itself whereby other tissues may be substituted for the destroyed parts, and the surgeon not only may have the satisfaction of seeing his patient go out with a useful limb, but he may also feel repaid for the time and labor devoted to the individual whose limb he saved. Besides he is spared that compunction of conscience and the element of doubt as to the course pursued had he sacrificed an essential part of the body before trying conservative methods.

Such a case illustrating the point under consideration was brought to me by Dr. J. D. Norton of Wildwood Springs, Tenn., and which I hereby report as follows:

December 27, 1910, Leonard D., farmer, aged twenty-one, a fine specimen of physical manhood, was out hunting with an old fashioned breech loading hammer gun. Attempting to cross a picket wired fence, he thrust the barrel of the gun, muzzle first between the pickets, the butt of the gun resting on the near side of the fence. He then climbed over the fence, and as he did so, being a heavy man, he bent the fence forward. As he attempted to pick up the gun by the muzzle, the stock still being in the fence, the fence flew back and in so doing caught one of the hammers in the wire. As a result the gun was discharged; the load tore away the front of the man's axilla, the insertion of the pectoralis major, and the upper third of the biceps muscle;

it also made an oblique fracture of the surgical neck of the humerus.

The patient lived twenty miles in the country, consequently I did not see him until the next morning, as it was impossible to get him to the hospital earlier.

Examination showed a fearfully lacerated and contused wound, laying open the entire axillary space, exposing the brachial plexus of nerves, the main axillary vessels, and the deltoid muscle which were intact.

I nailed the fractured ends of the bone together (the nail subsequently loosened up and was removed) and packed the wound with corrosive sublimate gauze. The wound was kept open and packed with corrosive sublimate compresses in order to allow the devitalized tissue to slough and in order to watch developments, such as secondary hemorrhage, etc.

January 3, 1911, he had a slight hemorrhage from the anterior circumflex artery, which was controlled by compression. January 10, 1911, he nearly bled to death from sloughing of a branch artery near the brachial, as the blood ran down under him and was not noticed by the attendant. This was also controlled by packing. For twenty-four hours he hovered between life and death but finally rallied satisfactorily.

After all necrotic tissue had been thrown off and the suppuration had nearly ceased and the wound had commenced to cicatrize, the problem became important to devise some way to give him a useful arm and to cover over the axillary space.

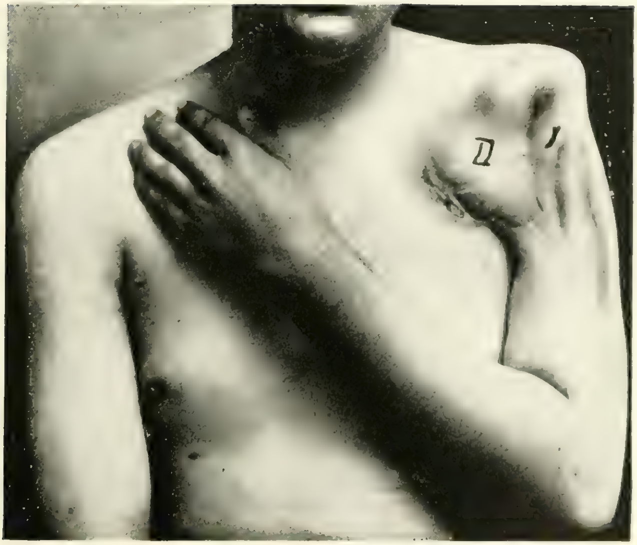
I did not wait for complete cicatrization before operating on account of the danger of scar tissue causing ischæmic paralysis and the probability of great difficulty in identifying the different structures.

In order to understand the steps taken to restore the function of the arm and shoulder, it will be necessary to remember the condition of things confronting us.

Here was a patient with the axillary space laid open, the axillary vessels and nerves exposed, the biceps nearly to the middle of the arm gone (making flexion of the forearm impossible), the head of the humerus ankylosed, and a fracture of its surgical neck.

It occurred to me that by resecting the head of the humerus with an inch or more of the shaft we could shorten the arm

FIG. 1.



Showing result of plastic to cover in defect of wall of axilla caused by a gunshot wound. I, ribbon of skin taken from arm; II, flap from chest. Note the degree of flexion of the forearm.

enough to use, without tension, the coracobrachialis and anterior half of the deltoid muscles as fixed points of attachment for the biceps muscle if it were sutured to its upper end.

Having offered this plan of operation to the patient, he readily accepted the suggestion. So, February 8, 1911, I removed the ankylosed and carious head of the humerus and resected an inch or more of the shaft; then loosened the insertion of the coracobrachialis and the anterior half of the deltoid and sutured them with several strands of catgut to the freshened upper end of the biceps muscle. In order to lessen tension on the sutures the arm was kept in hyperflexion.

These different steps of the operation being completed, there still remained to cover over the axillary space. To do this a flap of skin was dissected from the front of the chest and slid over the axillary space and united with a narrow ribbon of skin crowded from the arm. The flaps readily united at their apposing edges and the raw surfaces exposed by their removal were allowed to granulate and cicatrize.

That the methods pursued to give this man a useful limb, and that the period of operation was well timed have been justified by the subsequent course of events.

The patient's arm is filling out and he says for carrying purposes is as strong as his sound arm. Of course the latitude of motion is not as great as before the injury and probably will never be; while he cannot carry his hand to the top of his head, he can, however, feed himself, wipe his face, and carry his fingers to the opposite shoulder with the injured limb.

The nerve supply of the arm and forearm is intact, and the radial artery at the wrist is unimpaired. In fact the upper limb from the elbow down is normal.

It is well in this connection to mention that at times he has associated movements—when he attempts certain motions, as in raising the shoulder, when flexing the forearm, and *vice versa*. In fact, Dr. Wm. R. Cochrane, who examined him at my request, could cause contraction of the fused deltoid and biceps by placing one pole of a galvanic current over the grafted deltoid and the other pole over the brachial plexus at the root of the neck.

The accompanying photograph (Fig. 1) taken July 8, 1911, shows the condition of the patient nearly seven months after the injury.

ON IMPACTED FRACTURES THROUGH AND NEAR THE FEMORAL NECK.

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THE main object of this paper is to call attention to the comparative frequency of impacted fracture near and through the neck of the femur, and to point to some features which may cause difficulty in diagnosis. The subject of injuries around the hip is time-worn, but many facts demonstrated by the Röntgen rays have not yet obtained due prominence in the current text-books on general surgery. Till comparatively recent years, the question of fracture near the hip resolved itself into distinguishing between "intracapsular" and "extracapsular" fractures of the femoral neck. Hard and fast distinctions were laid down whereby the one or other could be diagnosed, and outside the conventional types of injury diagnosis was doubtful. Intracapsular fracture of the neck of the femur was said seldom to be due to direct violence and rarely to be impacted. This teaching must have been responsible for many mistakes in diagnosis.

We are concerned here only with those injuries in which impaction occurs. These are almost always due to direct violence. In the event of direct violence being applied over the great trochanter, as in the common accident of a fall upon the hip, the force is transmitted along the femoral neck. This oblique force can be resolved into a horizontal crushing component which leads to impaction, and a vertical component which is most likely responsible for the upward displacement of the trochanter and shaft. According to the exact direction of the applied force, these horizontal and vertical components vary, and there result different kinds of fractures and displacements. In the case of indirect violence, it is rare to get impaction primarily, though this may result from the fall upon the trochanter which frequently follows.

It is a law of mechanics that when a force acts transversely to a straight rigid rod fixed at one point, the breaking strain at any particular place is greater the nearer to that fixed point. In the case of a jar transmitted upward through the femur, the line of force passes vertically up through the top of the shaft and acts more or less transversely to the neck. The centre of rotation in the head may be taken as the fixed point, and the breaking strain along the neck will increase as the head is approached. This accounts for the fact that indirect violence usually causes a fracture of the neck just below the head (subcapitalis) and also for the occasional separation of the epiphysis of the head from a similar injury. It will be noted, however, that such indirect force only tends to produce vertical displacement, and there is no horizontal force which would lead to impaction.

The form of direct injury which causes an impacted fracture is usually a fall, whereby the hip strikes the ground, more rarely some heavy object falling on the hip may be responsible. The precise lesion resulting depends upon the age of the patient and the direction of the injuring force. Up to the age of twenty, at which time the epiphysis of the head should be joined to the neck, it is not unusual for the epiphyseal attachment to give way and a traumatic coxa vara to result, though fracture of the neck at this age is by no means unknown. During middle age and later years an impacted fracture of the neck or trochanter region results.

The position of the fractures cannot be foretold by considering the amount or kind of violence. Similar injuries may lead to fractures at different places.

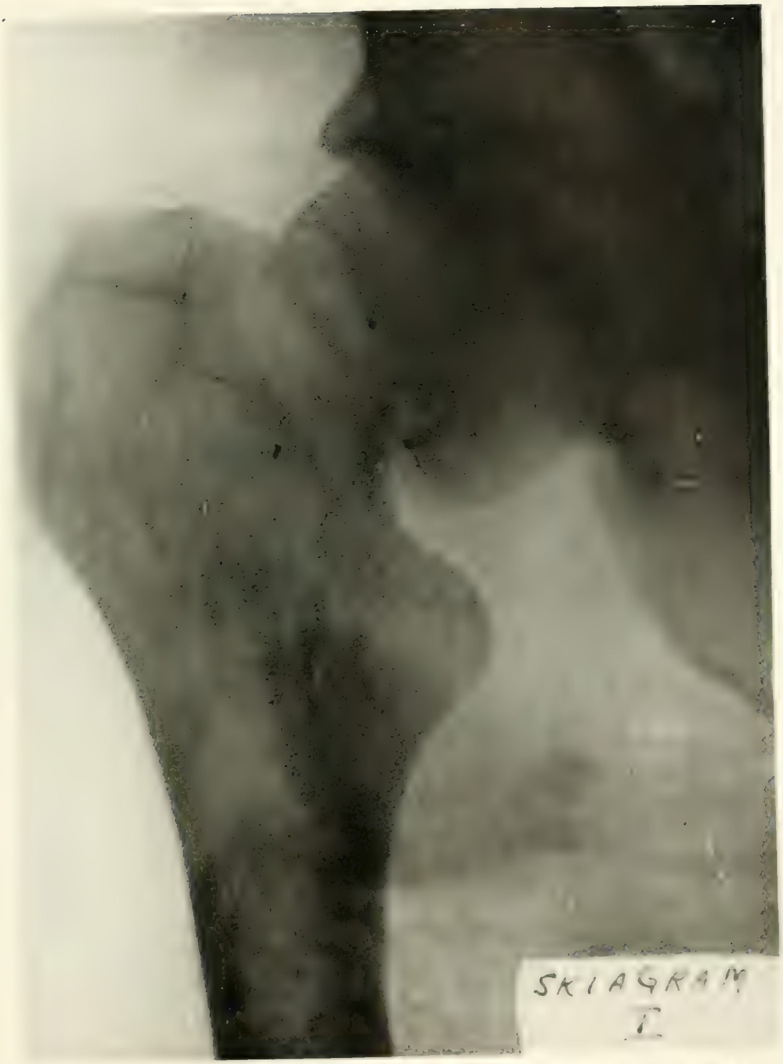
For descriptive purposes we may divide impacted fractures in this region into: (1) impacted fractures through the neck of the femur wholly within the capsule; (2) impacted fractures through the base of the femoral neck or in the trochanter region. It must be understood that by an impacted fracture we mean one in which the fragments are not movable on one another immediately after the accident. Many such a fracture becomes unimpacted owing to ill-directed manipulation. As soon as it is evident that serious injury has occurred, no rough handling should be undertaken before the X-rays have indicated the presence or otherwise of impacted fracture.

(1) Impacted fracture of the femoral neck within the capsule is not of such infrequent occurrence as the text-books would have us believe. A treatise on fractures published only last year states with regard to fracture of the neck of the femur: "rarely this form of fracture may arise from blows upon the trochanter." This statement perpetuates the traditional view held before the introduction of X-rays. It can be definitely asserted that it is comparatively common to find an impacted fracture of the femoral neck wholly within the capsule, resulting from violence directly applied over the great trochanter.

There are two groups of cases. The first conform more or less to the type description of "extracapsular" fractures, *i.e.*, shortening, eversion, and loss of power in the limb, but unless considerable violence is used crepitus will not be elicited. Bruising over the hip may or may not be a noticeable feature.

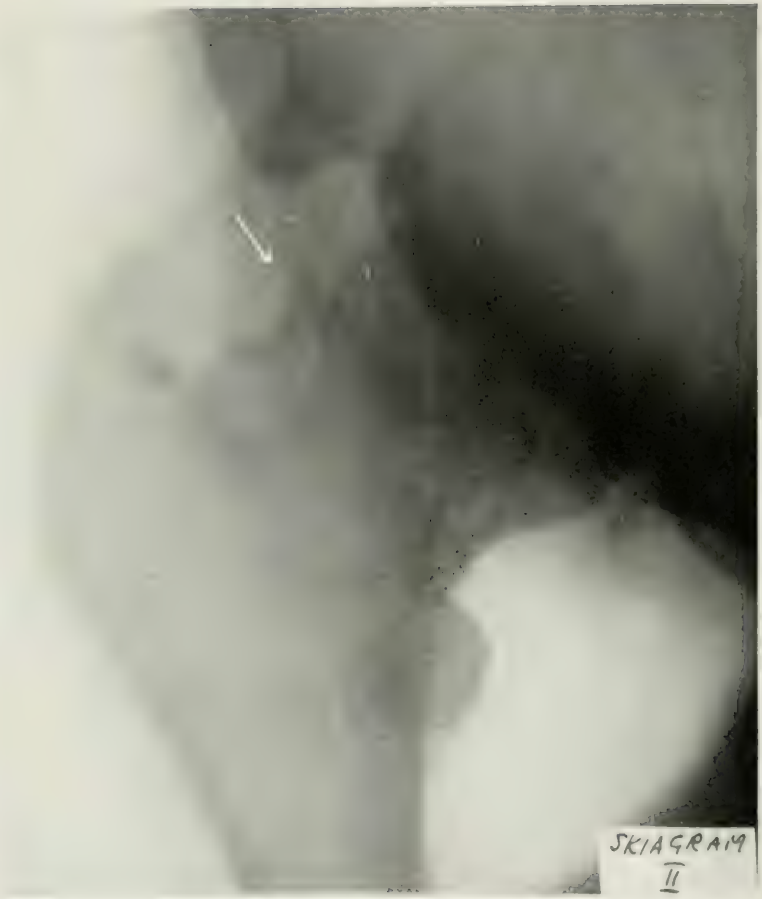
The second variety is atypical, and gives rise to varying deformity according to the direction of impaction. Slight shortening and various degrees of flexion, adduction, and inversion result. There are three reasons why an error of diagnosis may occur in this fracture. In the first place the shortening is but slight, half an inch or under being quite usual. Those who have done much measuring of lower limbs will appreciate the statement that differences of half an inch or under are not always easy to determine, for it may be difficult to locate the anterior superior spine accurately in a fat subject, and sometimes spasm of the muscles will prevent the limbs being adjusted symmetrically to the pelvis. Secondly, the impaction may produce an attitude of the limb not usually associated with fracture; for instance, in the

Skiagram I.



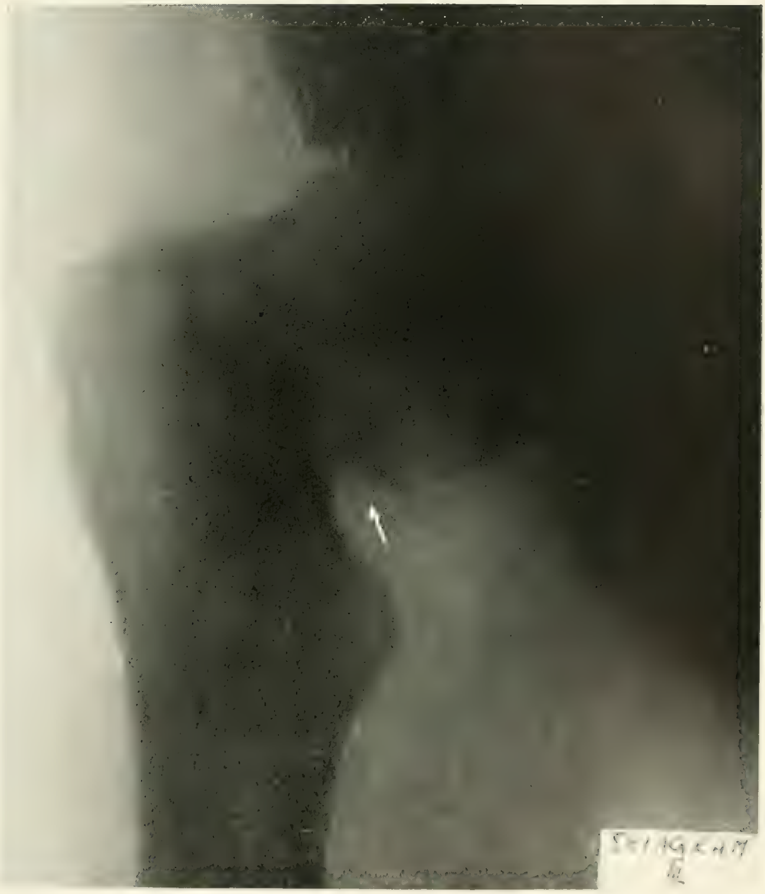
Impacted fracture of neck of femur near the head, [illegible]

Skiagram II.



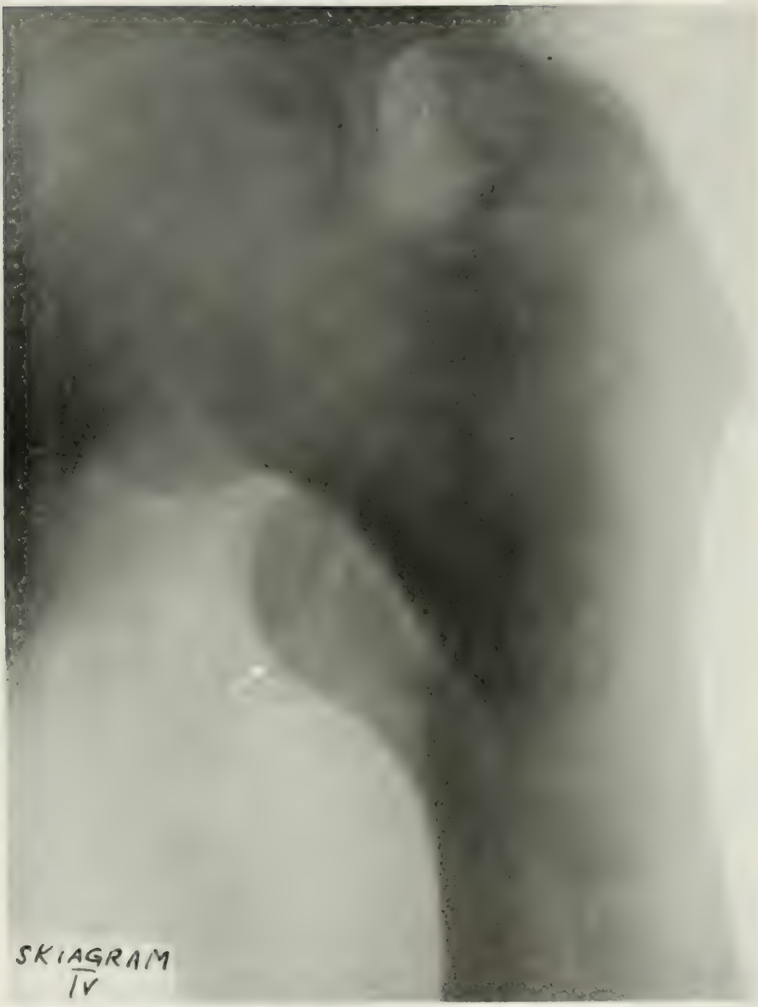
Impacted fracture of neck of femur associated with adduction and flexion of thigh. (Case II.)

Skiagram III.



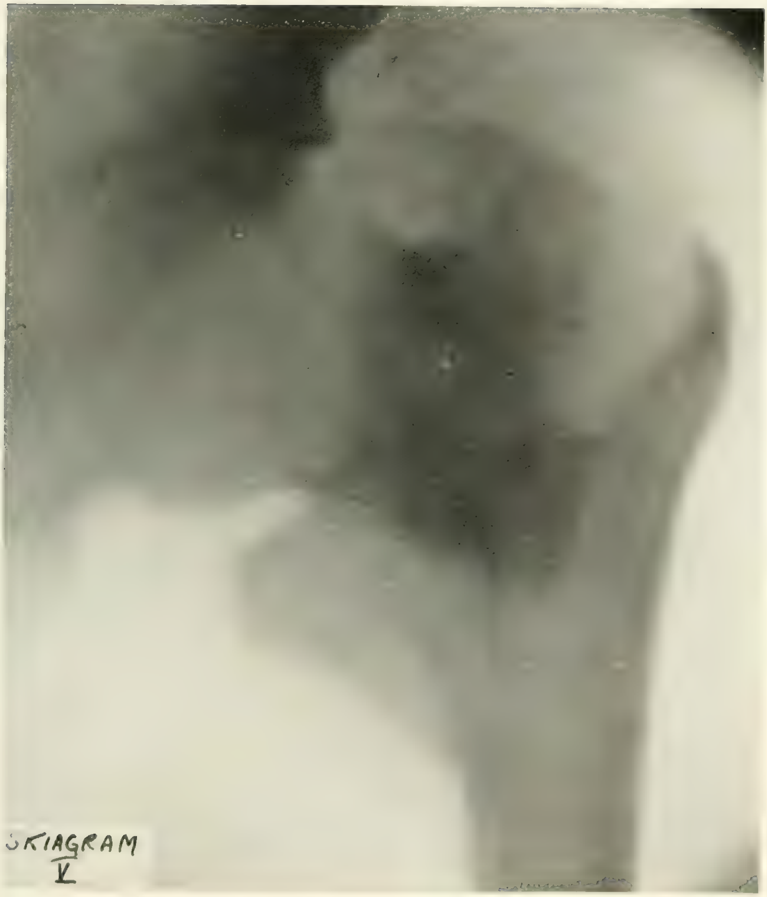
Impacted fracture through base of the neck of the femur (Case III). Skiagram taken five days after the accident.

Skiagram IV



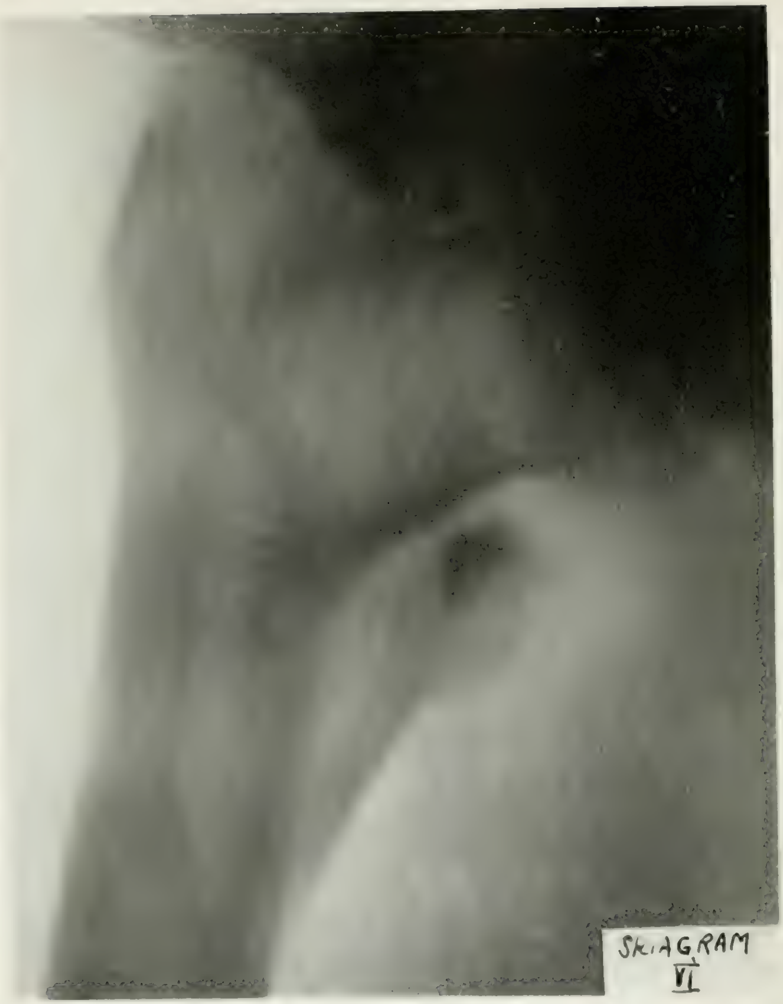
Fracture through the base of neck with impaction but no shortening. Arrows point to lines of secondary fracture. See Fig. [illegible] and Case V.

SKIAGRAM V.



Impacted fracture of base of neck. The common, typical form. The [illegible] great trochanter can be seen displaced inward. See Fig. [illegible]

Skiagram VI.



Impacted fracture through base of neck of femur. Third type of injury. See Case VII and Fig. 3.

second case quoted below, the position assumed by the limb resembled that due to a dorsal dislocation of the hip. Thirdly, the loss of function at the hip may not be complete. It may be possible for the patient to lift the limb off the bed or even to bear the weight on it and walk about, though limping.

As illustrations of the two groups of cases the following will serve:

CASE I.—W. P., aged sixty-five, was knocked down and fell on the right hip. On admission (September, 1910) there was eversion and slight abduction of the right lower limb, which was half an inch shorter than the opposite member. Pressure over the great trochanter was painful, but no bruising was visible. The iliotibial band was slacker than on the sound side. Voluntary movement at the hip-joint was just possible, but painful. Skiagraphy showed an impacted fracture of the femoral neck near the head, and wholly within the capsule (see Skiagram I).

This illustrates the first type. The second group is exemplified in the next case.

CASE II.—W. S., aged thirty-eight. Fell off a bicycle on the right hip three weeks before admission. For a short time he rested, but soon got about again, though he limped painfully. His injury was not treated as a fracture, and no improvement took place. On admission (August, 1910) he was still able to walk, though with difficulty. The right lower limb was three-eighths of an inch shorter than the left, and was kept in a position of flexion and slight adduction. Abduction was impossible. Rotation outward and inward was limited and painful. There was pain on pressure over the great trochanter, which was no nearer the middle line than that of the opposite side. A skiagram showed a fracture of the neck within the capsule and just below the head. The neck was impacted tightly into the upper part of the cancellous tissue of the head in such a way as to account for the adduction and flexion of the limb (see Skiagram II).

In both the above cases movement at the hip-joint was possible though attended by pain. In the second patient the position of the limb simulated dorsal dislocation, but by considering the nature of the injury, the small amount of shortening, and the rather atypical deformity, a diagnosis was possible apart from the X-ray finding.

Owing to the kindness of Dr. Harrison Orton I am able to include a skiagram of another case.

Case III.—Patient fell off a bicycle on to the hip. He worked for two days afterwards, getting about his ordinary vocation though with some pain. Then he was compelled to take to bed. The skiagram was obtained five days after the accident. It shows a tightly impacted fracture through the neck (see Skiagram III).

It is quite possible that some cases of fracture through the neck caused by indirect violence (*i.e.,* the common fracture in very old people) may become tightly impacted because of an immediate subsequent fall upon the trochanter of the affected side. In most of the cases I have seen, though chiefly affecting elderly people, this causation was negatived by the nature of the accident. The following case, which I am able to give owing to the courtesy of Mr. Warren Low, illustrates this possibility. I can do no better than give the account in Mr. Low's own words.

Case IV.—"The patient was an active old gentleman aged seventy-three, who, two years before I saw him, whilst travelling in Italy, tripped and fell upon his trochanter. He continued his sightseeing for the day, but stayed in bed for the next five days. He was afterwards able to get about, visiting Florence and Rome. He had been seen by an Italian doctor who assured him that nothing was broken. This assurance was repeated in Paris where he again sought advice, and again when he reached London. I may mention that he stated that, some time after the accident, while travelling to Paris in a jolting train he felt a sudden sharp pain in the hip region, and ever after that the hip gave him more trouble. I saw him two years after the accident, and whatever may have been obscure before, was then quite obvious. The movements round the left hip-joint were quite free with the exception of internal rotation and abduction, but active movements though free were feeble. The limb was one and a half inches shorter than its fellow, and the trochanter was above Nélaton's line. Moreover, on rotating the femur, the trochanter rotated on its own axis and not through the arc of a circle of which the neck of the bone was the radius. It was not a difficult matter to diagnose a fracture of the neck of the bone with a false joint, and this was confirmed by skiagraphy."

This case must have been a tightly impacted fracture at the first, else it could not have been altogether missed by the doctors who saw him at or soon after the occurrence of the accident.

(2) Impacted fracture through the base of the femoral neck and the trochanter region includes all those which used to be loosely called "extracapsular fracture of the neck," a terminology anatomically incorrect and clinically of doubtful value.

From outward appearance it is often difficult or impossible to tell whether this fracture or an impacted fracture near the head has occurred. Both occur in middle or old age, and result from the same kind of violence. Perhaps slightly greater force is responsible for fracture through the base of the neck, for shortening and eversion of the limb and bruising over the trochanter are more marked in these cases. Owing to this greater bruising and more severe injury, movement at the hip is more uncommon. But the mechanism of the two fractures is quite different. In fracture through the neck the firm tissue of the lower part of the neck is driven and tightly impacted into the cancellous tissue of the upper part of the head; in fracture through the base of the neck the cancellous tissue of the great trochanter is split up by a firm wedge of bony tissue belonging to the cervix femoris. This wedging of the cervix into the trochanter region is responsible for two or three secondary fractures which frequently complicate the primary breakage (see Fig. 1).

One is due to vertical splitting of the great trochanter, and usually separates off the posterior part of the great trochanter and the adjoining bone, including the lesser trochanter and even a little of the shaft beyond; another is horizontal, and detaches the top of the great trochanter from the previous fragment. Occasionally, and probably from a greater degree of violence, the lesser trochanter and a flake of adjacent bone from the shaft are split off, owing to the cutting action of the lower compact tissue of the neck.

It has been pointed out by Ralph Thompson that the calcar femorale probably plays an important part in the causation of these secondary fractures. The calcar is a vertical plate of more compact bone standing upright in the midst of the cancellous tissues of the femoral neck. Its base is attached to the inner and under surface of the neck as far down as the lesser trochanter, and its outer edge points like a vertical razor edge towards the great trochanter. When a force is applied over the hip, this firm blade tends to split the great trochanter in a more or less vertical direction. From a study of skiagrams it would appear likely that the upper layer of compact tissue of the neck acts as a blade to produce the secondary horizontal fracture. It seems likely that the lower layer of compact tissue of the neck is responsible for the occasional splitting away of the lesser trochanter and adjacent portion of the shaft.

Three grades of injury have come under my notice. In the first a primary fracture occurs at the junction of the head and neck, and the base of the neck is then thrust into the cancellous tissue of the great trochanter. The lines of the secondary fractures (horizontal and obliquely vertical) can be seen, though no separation of the fragments takes place (see Fig. 1 and Skiagram IV).

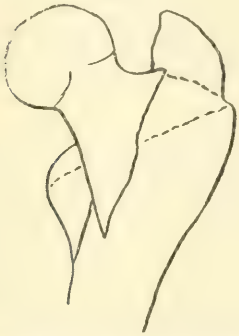
The second grade shows a more advanced condition. The firm tissue of the neck causes separation of the fragments of the trochanter along the lines previously mentioned. The base of the neck loses its support, and marked shortening occurs. The tip of the great trochanter is nearly always drawn inwards toward the upper rim of the acetabulum. This is probably due to the action of the numerous muscles attached to its upper border. This grade of injury is the most common type of fracture resulting from a fall on the hip (see Fig. 2 and Skiagram V).

A third type of injury is shown in Fig. 3 and Skiagram VI. In it the process is carried one stage further, for the small trochanter and a slice of shaft are also split off.

The following are illustrative of the three types:

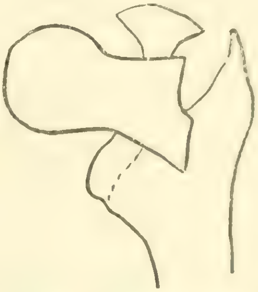
Case V.—J. B., aged forty-two (admitted February, 1911). Gave history of stumbling and falling heavily upon the left hip as he was trying to get into a train. When admitted, there was eversion and slight adduction of the left lower limb. No shortening was obtained, but there was definite relaxation of the iliotibial band. Some indefinite crepitus was felt on moving the femur, but this was elicited only once or twice. The patient could move his limb at the hip, though with some pain. The skiagram showed a fracture through the base of the neck which ended below in the lesser trochanter. The dense neck had been firmly impacted into the cancellous tissue of the upper portion of the shaft, and had begun to split off the upper part of the great trochanter. No shortening was obtained, since there was no alteration of the angle of the neck with the shaft, and no displacement in a vertical direction. The only positive

Fig. 1.



Showing lines of primary and secondary fracture in Case V.

Fig. 2.



Showing lines of separation in common type of fracture through base of neck.

sign was relaxation of the iliotibial band (see Fig. 1 and Skiagram IV).

The effects of still greater violence, or of similar violence acting on an atrophic bone, are shown by the following:

Case VI.—E. S., aged seventy-nine. Was accidentally knocked down by a blind man and fell upon her left hip. On admission, pain made examination difficult. The left lower limb was everted, and there were two inches of shortening. Voluntary movement was just possible, but very painful. The X-ray negative revealed an impacted comminuted fracture through the trochanters. The neck had evidently been wedged in between the two trochanters and separated portions of both. The appearance was exactly as if a further amount of violence had been applied to the previous case. The angle between the neck and shaft had been diminished almost to a right angle. See Skiagram V and Fig. 2.

This case shows why shortening varies so greatly in fracture through the base of the neck. When the force is only of moderate severity, the neck is firmly fixed by its impaction into the neighboring cancellous tissue; but when the impact is severe enough to break up the trochanter, resistance to vertical displacement disappears, and the vertical component of the injuring force leads to considerable displacement and shortening.

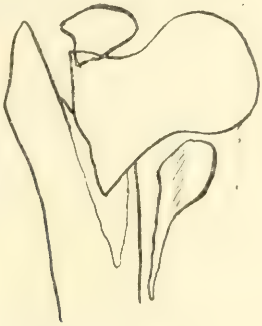
In view of the fact that the top of the trochanter is drawn inward, it might be advisable to put some of these fractures up in an abducted position. Skiagram V and Fig. 2 show a similar condition, though not taken from this actual case.

A still further degree of violence occurred in a case more recently in St. Mary's Hospital.

Case VII.—Patient fell a distance of 25 feet upon the right hip. On admission there was much bruising over the right hip, and one and a half inches of shortening. The iliotibial band of fascia was relaxed on the affected side. Crepitus was elicited.

The limb lay in an everted position and no voluntary movement was possible. There was a swelling in the upper part of the thigh. A skiagram showed a fracture through the base of the neck with separation of the lesser trochanter and a slice of the adjacent shaft (see Fig. 3 and Skiagram VI). The lower end of the cervical wedge caused this detachment.

FIG. 3.



Showing the third type of fracture through base of neck (Case VII).

CONCLUSIONS.

1. Impacted fracture of the neck of the femur (within the capsule) is by no means an uncommon occurrence.

2. It results from direct violence applied over the trochanter major, and may permit of considerable voluntary and passive movement of the hip without crepitus.

3. An unimpacted fracture resulting from indirect violence may occasionally be converted into an impacted fracture owing to an immediately subsequent fall upon the affected hip.

4. The impaction may cause an atypical deformity, even sometimes simulating dorsal dislocation.

5. Fracture of the base of the neck is always primarily impacted; if the force applied is great, there are always secondary fractures, both vertical and horizontal, through the trochanter region.

6. Persons with impacted fractures of the femoral neck or base of the neck may and often do walk about for some days after the accident.

7. An impacted fracture of the base of the femoral neck may exist without appreciable shortening when the force is not sufficient to cause the trochanter region to be split up by the wedge-like cervix femoris.

In conclusion I wish to express my indebtedness to Dr. Harrison Orton for his kindness in allowing me to make use of all the radiographs inserted.

NOTE ON CATGUT STERILIZATION.

A PRELIMINARY REPORT.

BY WILLARD H. HUTCHINGS, M.D.,
OF DETROIT.

SEVERAL years ago the writer began an experimental study of the various methods which have been employed for the sterilization of catgut. The longer I worked with them the more I became convinced that the secret of catgut sterilization lay in the complete removal of all traces of water. After trying a great many methods, most of which failed, the following was evolved which will sterilize catgut without impairing its physical qualities. The point of the method lies in the way the water is removed. This is done in a vacuum over sulphuric acid. It is a well-known physical fact that in a vacuum of less than 4 mm. of mercury water vaporizes. For example, a piece of ice placed in a desiccator under less than 4 mm. pressure will remain ice until it completely disappears without liquefying. The sulphuric acid absorbs the water vapor as fast as it is formed. It is also well known that in the absence of water very few, if any, chemical changes take place. Therefore a perfectly dry catgut can be heated nearly to the charring point without materially injuring it. It has also been proved by repeated experiments that 150° C. dry heat for two hours will kill all germs, with few exceptions, these being non-pathogenic. This is the, almost universal, method employed by bacteriological laboratories to sterilize infected glassware, etc.

Based on these principles, the method I employed is as follows: Raw catgut without any previous treatment is placed in suitable containers which are left open. In my work I have employed a simple straight glass tube sealed at one end, the other being open. These tubes are then placed in an ordinary vacuum desiccator, the bottom of which is covered with sulphuric acid and connected with a vacuum pump. The air is then exhausted until a pressure of less than 4 mm. is secured, the more perfect the vacuum the better the result. When this is attained the desiccator is closed, disconnected from the pump, and set aside. Eight days are long enough to secure dryness. At the end of this time air is allowed to enter the desiccator. If perfectly dry air is needed it can first be passed through Wolff bottles containing sulphuric acid. The tubes are then rapidly sealed and are ready to sterilize. Any method of heating may be employed. Hot air ovens have been found uncertain, as it is very difficult to regulate the temperature. In my work I have employed a mixture of glycerin and distilled water with a boiling point of 150° C., the container being fitted with a reflex condenser. The sealed tubes are placed in this and boiled two hours, thus securing two hours of dry heat at 150° C.

Any method of sterilizing catgut must fulfil certain requirements. First it must render the catgut sterile. It is not sufficient that it kill the various micrococci, colon bacillus, typhoid bacillus, and possibly anthrax. It must absolutely destroy every germ which may in any remote way produce infection. And it must do it every time. Sterility is the prime requisite. In addition, the physical characteristics of the catgut should not be impaired. It must be strong, elastic, absorbable. In order to test the sterilization of gut prepared in this way, the following experiments were undertaken: Number 4 catgut was cut in one and one-half inch lengths and placed in 250 c.c. Erlenmeyer flasks, containing suitable culture media. These flasks were then inoculated with "hay" bacillus, "potato" bacillus, anthrax, tetanus and dirt from the street (aërobic and anaërobic) and incubated at 37.5° C. for 21 days. At the end of this time they were removed and submitted to the sterilizing process above described. One hundred and fifty samples of each kind of infected gut were used. They were then planted in suitable culture media and incubated for 14 days. Not one of the samples gave a growth. There were also no contaminations. In order to be perfectly sure that they were sterile, twenty-five samples of anthrax and tetanus gut were transplanted into guinea pigs. In no instance did they produce anthrax or tetanus in the animal. Control animals which were inoculated with the gut before sterilization died of the diseases.

The tensile strength of the gut was tested in the following manner: Samples of gut one foot in length were attached at one end to a self-registering scale, at the other to a windlass in such a manner that the strain could be applied steadily. Force was applied until the gut broke. In this manner one hundred samples of gut were tested before treatment and one hundred after sterilization. The raw gut gave an average breaking strain of 8.7 pounds, while the sterilized gut gave an average of 8.9 pounds. In other words, the sterilized gut was a little stronger than the raw gut. This is in accordance with the well-known fact that a dry piece of wood, for example, has a higher tensile strength than a green piece.

Tests for absorbability were made on guinea pigs and showed that No. 2 gut was absorbed in nine days. The appearance and elasticity of the gut is not altered by the process of sterilization. Instead of being roughened during sterilization it is even smoother than before. The following conclusions are justifiable:

1. That gut prepared by this method is sterile.
2. That its tensile strength is not impaired.
3. That it remains in the tissues long enough to fulfil the purpose for which it is intended.

Unfortunately the method is not simple. It requires rather complicated apparatus and a first-class vacuum pump. The above is in the nature of a preliminary report. It is intended to experiment further in an effort to not only simplify the method but to secure wider applications if possible.

THE TREATMENT OF LACERATED AND INCISED WOUNDS OF THE EXTREMITIES.*

WITH A REPORT OF FIVE TYPICAL CASES.

BY JAMES A. KELLY, M.D.,
OF PHILADELPHIA.

Visiting Surgeon to St. Mary's Hospital; Associate in Surgery, and Pathologist to the Philadelphia Polyclinic Hospital and College for Graduates in Medicine.

ALTHOUGH marked advances have been made in the technic and treatment of abdominal conditions, our attention is often attracted to the fact that the treatment of lacerated, incised, and punctured wounds of the extremities has not kept pace with the work done in the other branches of surgery, and while the percentage of cases that were treated by primary amputation for destruction of the arterial or nerve supply, or by secondary amputation for gangrene due to thrombosis of infection, is not so great, the fact remains that the ultimate result, as shown in the loss of function, muscular atrophy, contractures, and the often-marked involvement of sutured tendons, nerves, and blood-vessels in one mass of cicatricial tissue, is very poor. This condition greatly limits the usefulness of the individual, decreases his earning capacity, and too frequently ends in prolonged lawsuits for indemnity. It is with the object of bringing this common condition before the attention of the Fellows that I wish to present this report of five typical cases.

CASE I.—*Cartridge shell wound of the arm, involving the brachial artery, basilic vein, and median nerve; circular arteriorrhaphy, circular phleborrhaphy, and neurorrhaphy.*

Mrs. A. G., sixty-six, w. housewife, Germany, admitted to St. Mary's Hospital July 4, 1910. Patient, while walking along the street July 4, 1910, heard an explosion as a trolley car passed and at the same time felt something strike her in the upper arm, accompanied by a sharp stabbing pain in the same region which radiated down the forearm to the hand and fingers. The patient noticed a small amount of bleeding from the wound, and on account of this and the pain went to the hospital.

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* Read before the Philadelphia Academy of Surgery, May 1, 1911.

On admission the arm was thoroughly cleansed and an antiseptic dressing applied. The wound was not considered to be of great importance by the resident physician and he did not notify me until the next morning, when examination showed complete paralysis of the muscles supplied by the median nerve and apparently no injury to other important structures. The arm showed a small transverse wound 1 to 1.5 cm. long on the anterior surface of the right arm about the junction of the middle and upper thirds, through which there was a small amount of blood oozing. The entire inner aspect of the arm was swollen over an area of about three to four inches and was ecchymotic. Radial and ulnar pulses were distinctly palpable, but not as full as on the left side. An X-ray examination showed the presence of a small foreign body about 8 to 10 mm. square.

Under ether anæsthesia longitudinal incision 5½ inches in length was made, with its centre at the wound of entrance. On cutting through the deep fascia a large blood-clot was evacuated, and this was followed by a gush of arterial blood. A tourniquet above the wound and a careful dissection showed a transverse wound of the brachial artery involving half of its calibre, almost complete severance of the median nerve, and a transverse wound of the basilic vein involving its entire calibre. Further dissection revealed a small piece of a cartridge shell about 1 cm. square imbedded in the coracobrachialis muscle. The wound was thoroughly irrigated with hot normal salt solution, the edges of the wound of entrance excised, and the wounds in the brachial artery and basilic vein were closed by circular arteriorrhaphy and phleborrhaphy by Carrel's method. The cut ends of the median nerve were united by means of two fine silk sutures passed directly through the nerve. The operative wound was then closed with continuous catgut sutures uniting the deep fascia and interrupted silkworm gut through the skin. Drainage was provided for through a small stab wound about two inches above the internal condyle, using rubber dam. A dry sterile dressing and an internal angular splint were applied. The wound healed by primary union; the drain was removed in 48 hours, and the sutures at the end of eight days. The patient was discharged at the end of three weeks and recommended to return for massage and passive motion.

Examination three months after operation showed normal pulsation of brachial and radial arteries, marked atrophy of flexor muscles, anæsthesia over areas supplied by median nerve; marked changes were present in the skin of the hand, particularly the fingers and thumb being thin, smooth, shiny, and cold; the nails were dry, dark in color, striated longitudinally, and there was marked sweating of the palm of the hand. There was marked stiffness of the elbow-joint in a position of semi-flexion, and also of the wrist and phalangeal joints. Voluntary flexion was absent in the fingers, was weak at the wrist-joint, and pronation of the hand was impossible. The patient complained of a general pain throughout the forearm and hand on attempts at movement.

Examination six months after operation showed a moderate return of sensation, muscular power, and a lessening of atrophic changes.

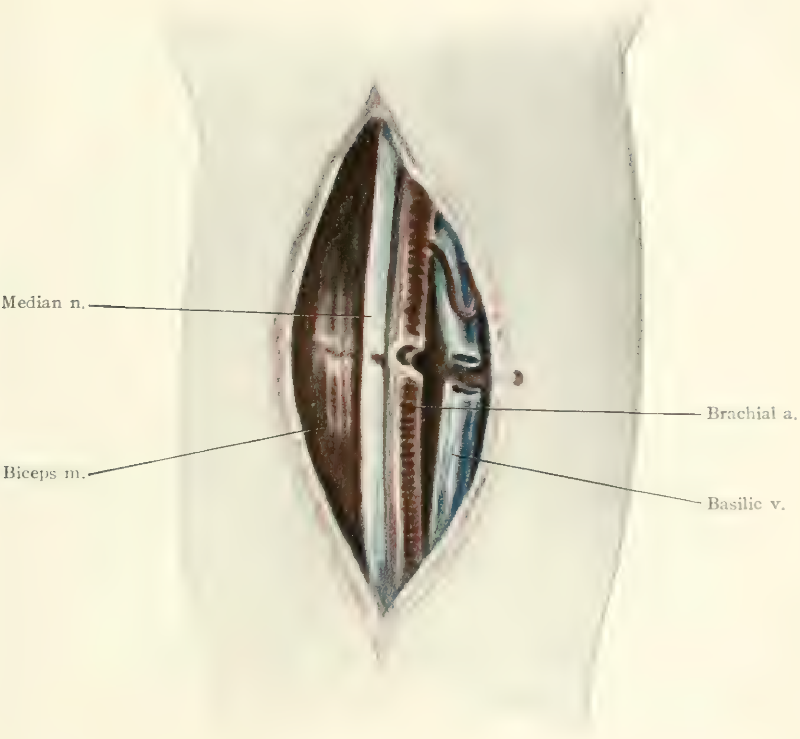
Examination March 30, 1911, showed a moderate degree of muscular atrophy, motions at elbow and wrist free, pronation and supination normal, flexion of fingers fair, still some trophic changes present over terminal phalanges, nails becoming smooth and normal in color at bases. No pain present on motion. General condition satisfactory.

CASE II.—*Lacerated wound of arm, severing biceps, portion of brachialis anticus, brachial artery, basilic vein, median and ulnar nerves; arteriorrhaphy, phleborrhaphy and neurorrhaphy.*

Jacob G., sixty-six years old, U. S., shuttle maker, admitted to St. Mary's Hospital September 23, 1910, at 2 P. M. Patient while at work had his clothing caught in a portion of the machinery and received a lacerated wound of the right arm from a circular saw. Admitted to the hospital in a profound state of shock.

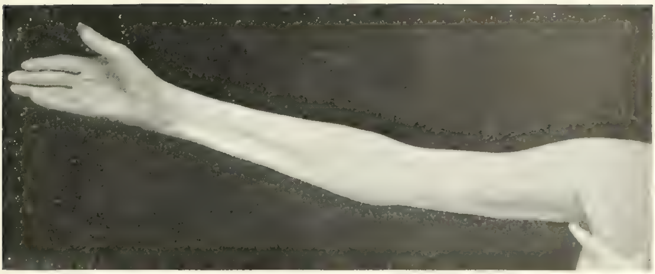
Examination on Admission.—Patient in a profound state of shock. On the right arm there was a lacerated wound about six inches in length, extending from the junction of the middle and upper thirds on the external surface running downward and inward. Inspection of wound showed the biceps muscle, the brachialis anticus muscle, brachial artery, the basilic and cephalic veins, the median and ulnar nerves to be completely severed and

Fig. 1.



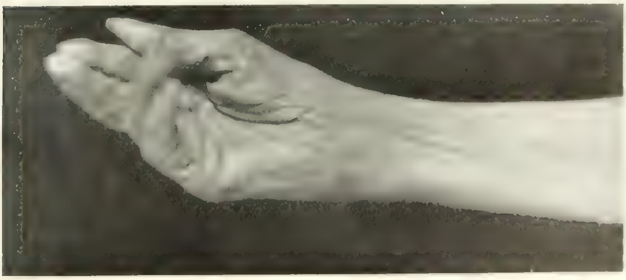
Lesion present after exposure by incision. (Case I.)

Fig. 2.



Shows healed wound with scar of punctured wound at centre. Hand in position of full extension. Note the degree of atrophy still present. (Case II.)

Fig. 3.



Shows the degree of flexion present, which is limited entirely by the [illegible] [illegible] in the phalangeal joints. (Case II.)

the cut ends retracted, and the wound partially filled with blood-clot. The bleeding had been temporarily controlled by means of a cloth tourniquet. The patient was given an intravenous injection of one litre of normal salt solution, a shock enema and a temporary antiseptic dressing placed around the arm. At the end of three hours the patient had sufficiently reacted from shock to warrant operative intervention.

The patient was given morphine ¼ gr., atropine 1/100. The arm was thoroughly cleaned with soap and water and alcohol 70 per cent., and the wound irrigated with hot normal saline solution. Circular arteriorrhaphy of the brachial artery and circular phleborrhaphy of the basilic vein were performed, using the method of Carrel. It was then found necessary to give the patient a little ether to continue the operation. The cut ends of the median and ulnar nerves were sutured with fine silk by the direct method, and the cut portions of the biceps and brachialis anticus muscles were sutured with No. 1 interrupted chromic catgut, the fascia and skin being united with interrupted sutures of silkworm gut and drainage provided for at the lower angle of the wound with rubber dam. A sterile dressing and an internal angular splint were then applied. The patient was fully stimulated, and in spite of everything that could be done he failed to react and died about ten hours after leaving the operating room.

CASE III.—*Incised wound of the arm involving the brachialis anticus muscle; the tendon of the biceps, the basilic vein, the median and ulnar nerves, tenorrhaphy, myorrhaphy, neurorrhaphy.*

M. McD., sixteen years of age, schoolboy, admitted to the Polyclinic Hospital, September 8, 1910, service of Dr. Louis A. Steinbach, to whom I am indebted for the privilege of reporting this case.

Patient while painting the outside of the window frame was supporting his weight with his hand against the window pane, when the latter suddenly gave way and the patient partially fell through the window severely cutting his right arm with a piece of the broken glass. Admitted to the accident room of the hospital in a state of shock with a tourniquet around the upper part of the arm.

Examination on admission showed patient to be in a moderate degree of shock. The right arm presented an irregular incised wound about four inches in length, beginning at the junction of the middle and lower thirds of the arm on the anterior surface running downward and inward. Retraction of the edges of the wound showed complete severence of the tendon of the biceps, a portion of the brachialis anticus muscle, the basilic vein, the median and ulnar nerves. Under ether anæsthesia the arm was cleaned with soap and water and alcohol 70 per cent., and the wound irrigated with hot normal saline solution. The separated portions of the brachialis anticus muscle and the tendon of the biceps muscles were sutured with No. 1 chromized catgut, the divided median and ulnar nerves were united with interrupted sutures of fine silk, the cephalic vein was ligated, and the fascia and skin closed with interrupted silkworm gut sutures. Drainage was provided for at the lower angle of the wound, and a dry sterile dressing applied. The wound showed a marked degree of infection several days after operation, which necessitated the removal of several of the sutures. The patient was discharged to the out-patient department for subsequent treatment September 24, 1910, sixteen days after admission. (Dr. Butler, Chief Resident.)

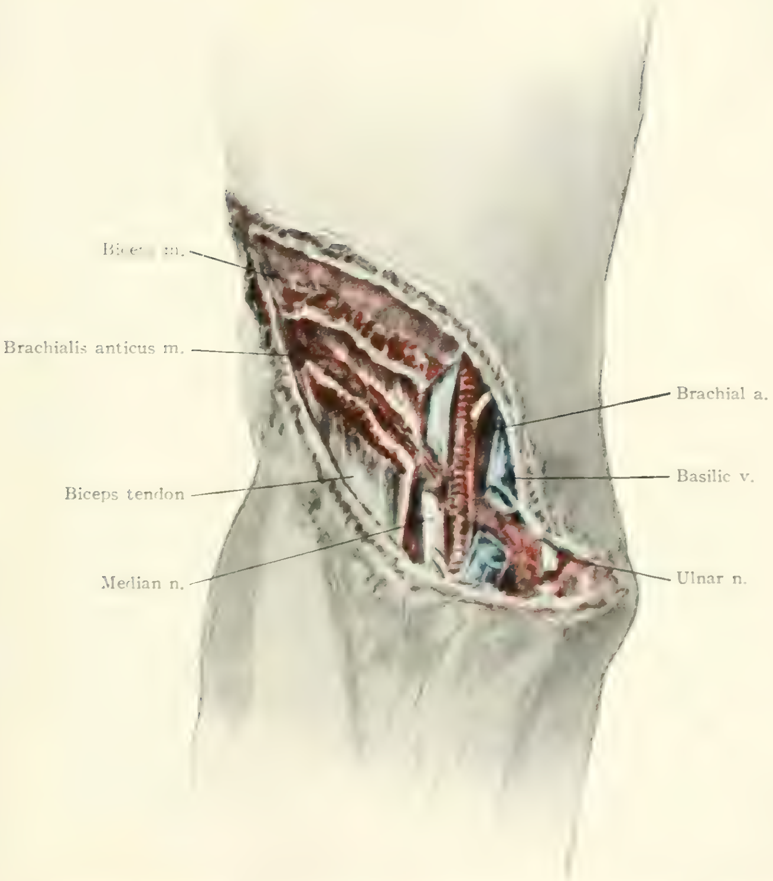
Examination March 30, 1911, showed normal flexion at the elbow, restricted motion of the wrist and of the fingers, most marked in the ring and middle fingers, still loss of sensation of index, middle, ring, and little fingers on flexor surfaces. Pronation and supination were still impaired.

Case IV.—*Incised wound of forearm, flexor surface, involving the tendons of the flexor carpi ulnaris, palmaris longus, flexor sublimis digitorum, flexor profundus digitorum, excepting the division to the index and middle fingers, the ulnar artery, and the median ulnar nerves; multiple tenorrhaphy, neurorrhaphy.*

E. P., thirty-seven years of age, machinist. Accident occurred January 18, 1911. Patient, while at work at Cramp's shipyard, was struck on flexor surface of right wrist by a piece of a falling arclight globe.

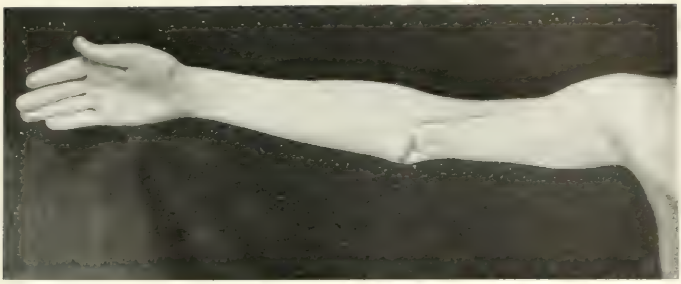
Examination on admission showed a transverse incised wound about two inches in length on the flexor surface of the right forearm one inch about the hand. Through the separated edges of the wound were seen the cut ends of the ulnar and median nerves, the cut ends of the ulnar artery, the divided ends of the tendons of the flexor carpi ulnaris, the palmaris longus, the flexor

FIG. 5.



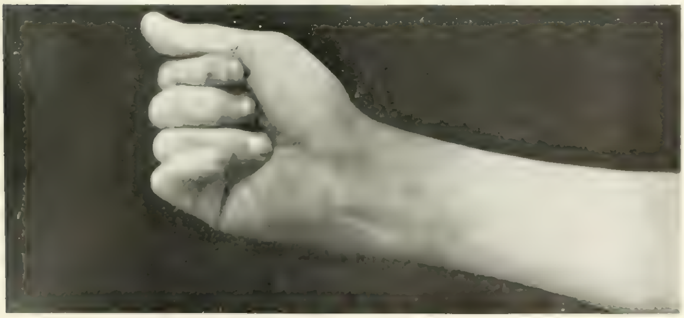
Showing the extent of the lacerated wound and the involved structures. (Case III.)

Fig. 6.



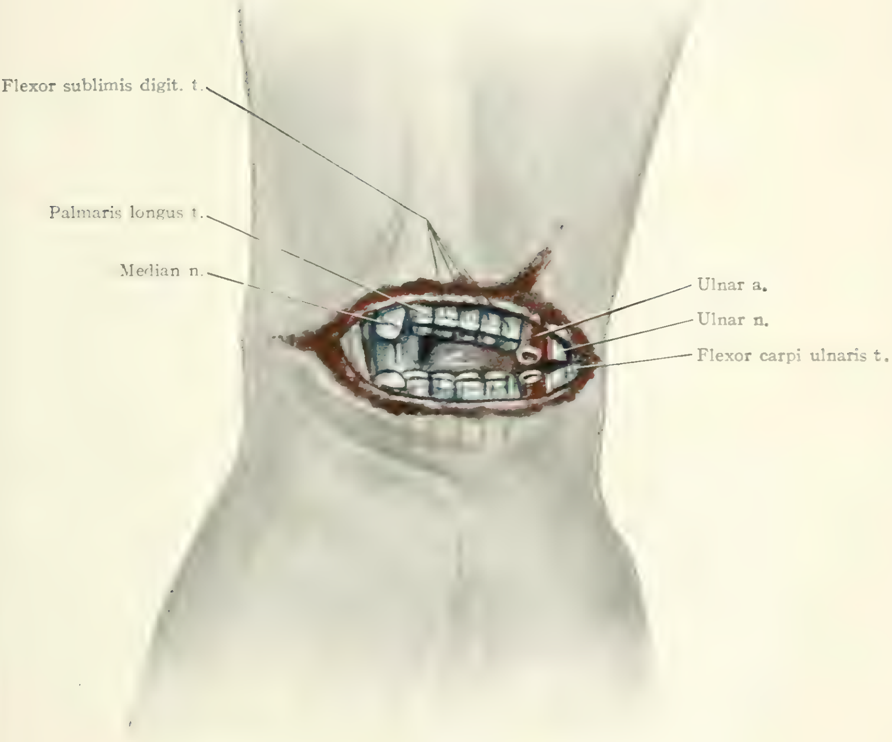
Showing the healed wound, the muscular atrophy, and the degree of extension of the hand. (Case III.)

Fig. 7.



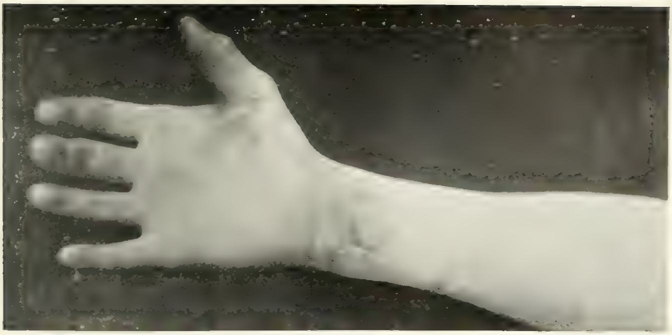
Showing the degree of flexion possible. (Case III.)

Fig. 8.



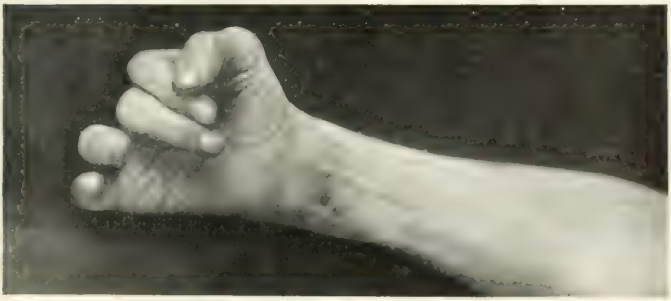
Showing the extent of the incised wound and the involved structures. (Case IV.)

Fig. 9.



Showing the healed wound and the amount of extension. (Case IV.)

Fig. 10.



Showing the degree of flexion possible. (Case IV.)

sublimis digitorum, and the flexor profundus digitorum, excepting the divisions to the index and middle fingers.

The operation was performed by the Resident Physician, Dr. McBride, without an anæsthetic, as the patient refused an anæsthetic. The arm was cleansed with soap and water and alcohol 70 per cent., and the wound irrigated with hot normal saline solution. The severed tendons were united individually with two interrupted sutures of silk, the cut ends of the nerves were united with interrupted silk sutures, the ulnar artery was ligated, the wound closed with interrupted silkworm gut sutures, a dry sterile dressing applied, and the hand dressed in extension on a splint. The wound healed by primary union, the sutures were removed on the eighth day and the splint at the end of two and a half weeks. Massage and passive motion were then instituted.

Examination March 30, 1911, showed the affected tendons to be firmly surrounded by scar tissue and united with the cicatrix of the skin; flexion of all the fingers was limited, particularly that of the ring and little fingers; cutaneous anæsthesia of hypothenar portion of the palm of the hand and the outer side of the ring and of the little fingers. There was marked tremor of the hand, which was cold and perspiring; the finger nails were moderately darkened, irregularly ridged, and longitudinally striated. The skin of the hand was thin, shiny, and bluish white. The scar was very tender and supersensitive. (In this case there is evidently separation of the cut ends of the ulnar nerve and a secondary nerve suture will be required.)

Case V.—*Incised wound of the flexor surface of the forearm one inch above the wrist-joint, involving the tendons of the flexor carpi ulnaris, the palmaris longus, the flexor carpi radialis, the flexor longus pollicis, the flexor sublimis digitorum, the flexor profundus digitorum excepting the divisions to the ring and little fingers, the median and ulnar nerves, and the ulnar artery; multiple tenorrhaphy and neurorrhaphy.*

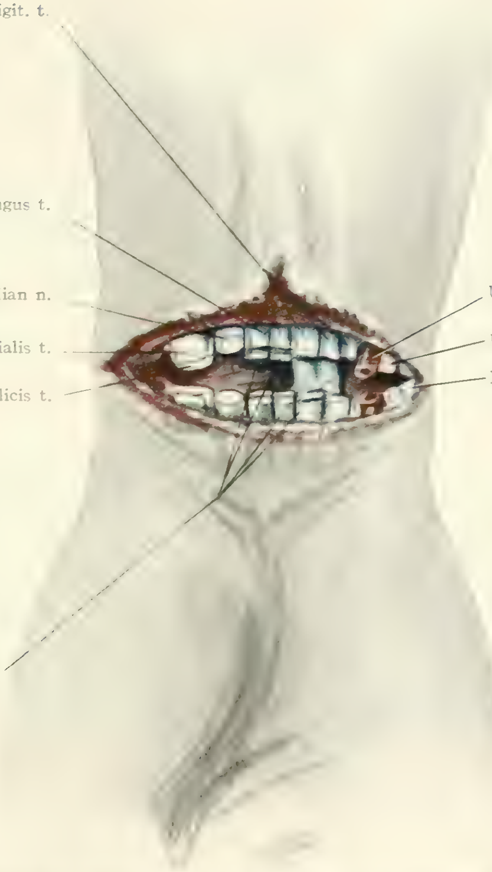
F. N., thirty-seven years of age, machinist. While at work the patient fell a distance of about 15 feet onto a skylight, the latter breaking, and he received an incised wound of the right wrist in addition to other injuries. Admitted to St. Mary's Hospital August 3, 1910. Treated by Dr. Wolf, Resident Physician. Ether anæsthesia.

Examination on admission showed a transverse lacerated wound about two inches in length of the flexor surface of the right forearm about one inch above the hand. Separation of the edges of the wound showed complete division of the flexor carpi ulnaris, the palmaris longus, the flexor carpi radialis, the flexor longus pollicis, the flexor sublimis digitorum, the flexor profundus digitorum excepting the divisions to the ring and little fingers of the latter; division of the median and ulnar nerves; and of the ulnar artery.

The forearm was thoroughly cleansed with soap and sterile water and alcohol 70 per cent. The wound was then irrigated with hot normal salt solution. The wound was then enlarged; the divided tendons were united separately with interrupted sutures of No. 1 chromicized catgut; the ulnar artery was ligated, and the divided ends of the median and ulnar nerves were separately united with through-and-through interrupted sutures of No. 1 chromicized catgut. The wound was then closed by interrupted sutures of silkworm gut. A dry sterile dressing was applied, and the hand and fingers placed in a position of marked flexion. The wound did nicely until the fourth or fifth day, when it was necessary to remove several sutures on the radial side of the wound, and it was found that there was a moderate degree of suppuration present which eventually resulted in a partial sloughing of the tendon of the flexor longus pollicis and separation of the cut ends. At the end of three weeks the wound had entirely healed. The patient has had very thorough and efficient massage since leaving the hospital, and is now at work.

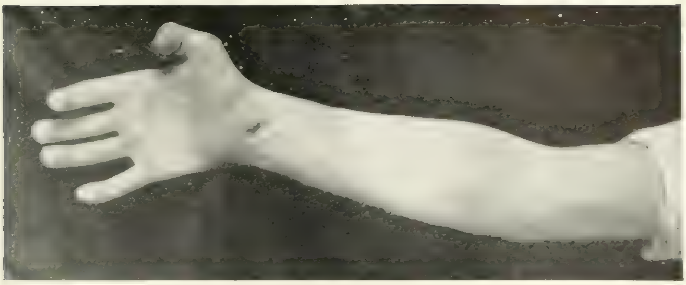
Examination March 30, 1911, showed very little atrophy of muscles, extension of the fingers was good, excepting that of the distal phalanges; extension of the thumb was limited by the fixation of the distal end of the flexor longus pollicis at the wrist, and flexion was absent for the same reason; and in addition it was apparent that the site of suture had given way, and the cut proximal end had retracted. Flexion of the fingers was good in all, but was still somewhat diminished in the ring and little fingers. Complete flexion was limited by adhesion of the tendons at the site of the injury. Trophic changes were still present, although rapidly diminishing on the fingers; the flexor surface of the fingers felt cold, also tips on extensor surfaces, skin was atrophic, and nails were slightly roughened and longitudinally striated.

FIG. 11.



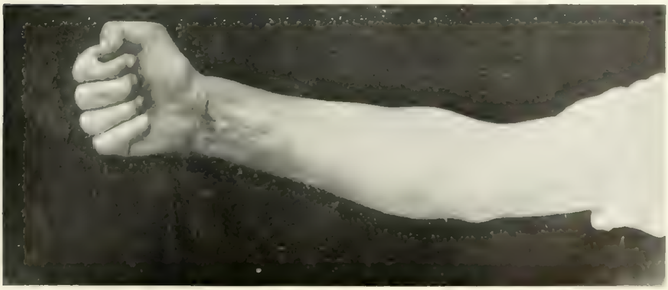
Showing the [illegible] wound and the [illegible] structures. [illegible]

FIG. 12.



Showing the degree of extension possible in the fingers, and the fixation of the thumb (Case V.)

FIG. 13.



Showing the degree of flexion possible. (Case V.)

The most common cause of incised and lacerated wounds of the extremities is from machinery accidents, gunshot wounds, explosions, cuts from scythes, glass, and sharp cutting instruments. In these accidents there is not only division of the superficial structures, but generally also division of muscles, tendons, blood-vessels, and nerves. In addition to the injury of the special structures there is very frequently, in lacerated wounds, a considerable destruction of the skin.

On first examining these wounds many problems are to be considered, dependent upon the extent of the wound and the structures involved. In the severe lacerated and incised wounds, where formerly amputation was the justifiable procedure, to-day entire parts are saved, useful limbs are preserved, and good functional results obtained by suture of muscles, blood-vessels, nerves, and tendons. Very frequently considerable judgment is necessary to come to the best possible conclusion, and in some cases operative procedure should be delayed on account of the shock so frequently present in many of these cases. Our primary interference should be limited to moderate cleansing, the removal of imbedded portions of clothing and foreign bodies, the ligation of small arteries, and an antiseptic dressing applied to the parts until the patient has thoroughly recovered from shock.

One of the most important problems in the treatment of these wounds is that of infection introduced at the time of the accident, either from the patient's clothing, his skin, or from the foreign body that produced the wound. Another very important consideration is the period that has elapsed from the time in which the wound was received and the time of seeing the patient. These two points have a great determining factor in the production of infection. In the treatment of these wounds they must all be generally considered as infected. We, however, know that very many of them can be thoroughly cleansed, and that they will heal by primary union. This is especially so of incised wounds. It is only from experience that we learn which ones should be drained, and which will probably heal without drainage. The chief infections to be feared are tetanus, streptococcus, gas bacillus, and staphylococcus forms. The great determining factors in the production of infection are the condition of the parts, clothing, and trauma at the time of the injury. A secondary determining factor in the extent of infection is the amount of the destruction of tissue produced by crushing. In addition to infection the most dangerous immediate effect of these wounds is hemorrhage. Fortunately to-day our means of combating hemorrhage are very efficient, and in the use of normal saline solution by hypodermoclysis, proctoclysis, intravenously, and in the more urgent cases by direct blood transfusion we are generally able to meet all of these cases successfully, if the patient is seen early enough and there is not too great a degree of shock present.

In many of these wounds the chances of primary union are not good unless they are caused by clean, sharp cutting instruments and thorough cleansing of the parts is instituted. In a large majority the edges of the wound are primarily grossly infected, crushed, and devitalized, and in spite of the most thorough cleansing, dirt and grease cannot be entirely removed from the skin, and the edges of the wound in its entire depth have been so badly devitalized that either sloughing occurs in clean wounds or the resistance of the parts has been so lowered that infection readily occurs. An interesting form of treatment in these cases is that suggested by Reclus, who prefers never to irrigate with antiseptic solutions, who does not advise primary closure of the wound, and who dresses the wound with antiseptic ointment of vaseline 300, antipyrine 5, boric acid 3, salol 3, iodoform 1, carbolic acid 1, bichloride of mercury 10. He irrigates the wound with hot water under high pressure and then places the above ointment directly to the wound. In the treatment of these wounds I think that the best results are to be obtained from the following methods: thorough washing with soap and water, shaving the entire part, a second washing with soap and water using a firm brush, then washing the parts with alcohol 70 per cent. for two minutes, and in cases where the skin is covered with grease or any other oily substance to wash with ether. The wound should be thoroughly irrigated with hot normal saline solution, all foreign particles removed, and all badly soiled and devitalized tissue should be cut away with a sharp knife.

After the above cleansing has been performed, a careful examination of the wound should be made for divided muscles, tendons, blood-vessels and nerves. The thorough approximation of these structures, especially the last two, is very important. Very often it will be found necessary to enlarge the superficial wound and to make a rather extensive dissection before the divided ends of all of the cut structures can be found. When deliberate suture has been performed, drainage of the wound must depend upon the degree of soiling by infectious material, the length of time that has elapsed since the accident, the amount of pressure destruction of the edges of the wound, and its position. The importance of a careful search for cut structures cannot be too greatly emphasized. How frequently do we see cases of comparatively trivial superficial wounds, in which division of important tendons and nerves has not been recognized until the resulting paralysis and atrophy call our attention to the nature of the injury!

OBESITY AND ITS SURGICAL TREATMENT BY LIPECTOMY.*

BY H. EDWARD CASTLE, M.D.,
OF SAN FRANCISCO, CAL.

It is a well-known fact that fat when in excess fails to perform the function for which it is intended, and becomes a burden to the life of its possessor. Adipose tissue has for some of its functions the preservation of the body, and the formation of beauty by producing symmetrical outlines. It fails to protect its possessor when it accumulates to such a degree that he is unable to perform the duties of life without extra exertion. When the inactivities of age begin to come to a person, his sedentary habits are greatly enhanced if he is endowed with an excess of fat. Thus the vital organs concerned in the metabolic processes of the body are incapacitated, and as the intake of food often remains the same, the result is, unfortunately, an increase of body weight.

If the adiposity is generally distributed we can do nothing but properly regulate the diet, exercise, hygiene, and general physical condition of the patient. Such patients are, obviously, not in the realm of the surgeon. They are subjects of the internist and should receive his careful attention. These patients are not interesting; there is very little to stimulate a scientific interest; they need constant attention to prevent them from regressing into their former modes of living, thereby undoing all that has been accomplished; and they are often discouraged at their slow progress. The result of this unfortunate fate is they read of and hear of advertised remedies and men who can reduce their weight rapidly, and they become martyrs to injurious chemicals and are the subjects of extortion by fraudulent men.

There is another class of patients to treat who are suffering from excess of fat. In these there are large localized areas of fat that can be removed to the advantage of its possessor. After discarding lipomas there are still collections of adipose tissue that are very detrimental to the welfare of the one to whom such belong. This is strikingly realistic in the abdomen of many people. Persons so afflicted cannot take the proper exercise; gymnastics and walking fatigue them so rapidly they do not get enough of either to be of much avail. The excess of weight often breaks down the arches of the feet, which condition is frequently associated with varicose veins of the legs, and ulcers. Sedentary habits are thus enhanced with sequelæ of incompetent liver, constipation, myocardial changes, etc. The contour of the body is unsightly, which keeps the individual out of society, and, if it chances to be a woman, induces her to wear harmful corsets to mold the form into a presentable appearance. The great weight outside of the centre of gravity gives her a mien which is ungraceful and embarassing. Eczema is prone to appear in the folds during hot weather.

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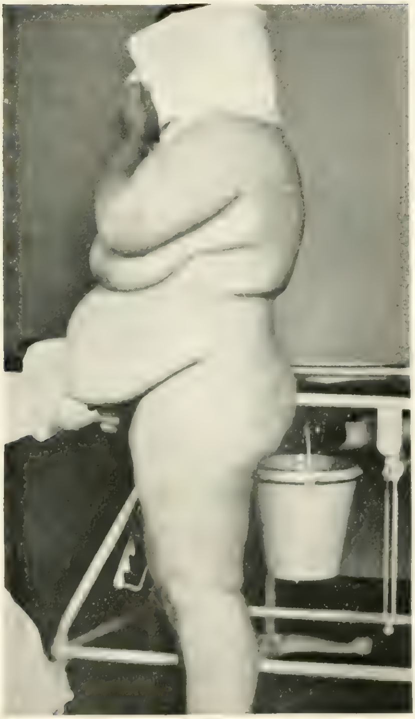
* Read before the Society of the San Francisco Polyclinic and Post-Graduate School, August 2, 1911.

Some of these unfortunate individuals have been relieved by a surgical removal of the pendulous abdomen. There remains a large number of people so afflicted who would submit to extirpation of the excess of such circumscribed areas of fat if their surgeons would suggest it and advise them as to its ultimate benefits.

The operation is of the most simple form in surgery and consists of an elliptical incision which encompasses the amount of tissue to be removed, and which extends down to the deep fascia. The area thus marked out can quickly be shaved from the deep fascia. We find the most useful instrument for this purpose is a medium size amputating knife. After ligating all bleeding vessels, the superficial fascia should be closed with catgut sutures and the edges of the skin brought together by interrupted silkworm gut. These sutures should be placed about one inch apart and about one centimetre from the edge of the skin. Very accurate apposition of the skin is very desirable, and is best brought about by a continuous horse-hair suture carefully placed. The greater the heed to this detail the more ready will be the healing of the wound. If due attention be paid to the closure of the wound, the scar will not be too unsightly and the convalescence will be much more agreeable to both patient and surgeon. The wound should be dressed with gauze which has been moistened with boric acid solution; this enhances the capillary attraction of the dressing and is a potential factor in relieving post-operative pain. If the binder which is destined to hold the dressings in place be drawn moderately snug the pain will be reduced to a minimum. It is easy to estimate the amount of tissue to be removed by endeavoring to approximate the fingers of the two hands when the mass is between them. If there is any tension on the sutures it can be relieved by flexing the body by the aid of a back rest in the bed. Local anæsthesia is not preferable in these cases, as the incision is too great in length. It is better to use general anæsthesia, the choice being nitrous oxide and oxygen, if there are no contraindications to its employment.

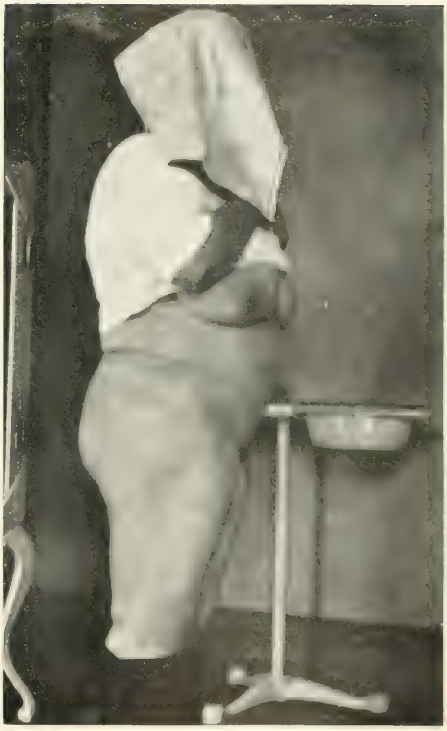
The operation was first called to the attention of the profession in 1890 by Demars and Marx.[1] Professor Howard A. Kelly[2] reported a case in 1899. The work of these gentlemen did not receive wide publicity, for we are unable to find many cases reported. Maylard[3] in 1907, Schulz[4] in 1908, and Weinhold[5] in 1909, all published records of their cases. In 1910 Kelly[6] wrote again advising the operation, giving it the name of lipectomy, describing this simple technic and reporting a very illustrative case. In the same year he pointed out the applicability of lipectomy while operating on very fleshy patients in order to make it possible for the operator to gain closer access to deep-seated pelvic lesions.[7] Ballard[8] reported one successful case in 1910 and Oehlecker[9] in 1911; both performed lipectomy while operating for umbilical hernia. In the same year R. Jolly[10] described his method of removing the excess of fat from the abdominal wall and reported two cases. It is possible that other cases have been recorded, but, if so, they are few, and we have not been able to learn of them during a careful perusal of the literature. Then, too, there are undoubtedly a large number which have not been

Fig. 1.



Shows pendulous abdomen.

Fig. 2.



Patient two months after operation.

published. It is the object of the writer in reporting this case to help in keeping this valuable operation in the minds of the progressive surgeons until it receives its deserved attention.

CASE I.—Lady, thirty-eight years old. A native of Sweden. Had had diseases of childhood. Menstruated at twelve years, irregular, and accompanied by pain. Married ten years; husband has nephritis. Two children; one is well; one has a nervous disorder which causes him to have incontinence of fæces when at work in school. Two years ago patient had a miscarriage which took place in the third month of gestation. Since this sickness she menstruates for ten days each month, during which time there is profuse flow. Patient is very constipated. She becomes fatigued and out of breath when taking the slightest exercise.

Physical Examination.—Heart action very irregular; this irregularity is markedly increased during exercise. Patient is 5 feet 3½ inches in height, and weighs 300 pounds. The adipose tissue is abundant in the abdomen and in the breasts, effecting a very awkward position while standing and extreme labor while walking. Both legs have large varicose veins below the knees; midway between the ankle and the knee on the anterior and the anterolateral surfaces of the right leg is a varicose ulcer which is 7 cm. in diameter. Trendelenburg's test for function of the valves in the internal saphenous veins shows they are competent.

The patient was sent to the hospital for Schede's varicose vein operation and Kelly's lipectomy.

Preparation of Patient.—Forty-eight hours prior to operation the ulcer and leg were cleansed with soap and water, then dressed with a gauze dressing which had been moistened in a solution of bichloride of mercury the strength of which was 1:10,000. The evening immediately preceding the morning of operation the abdomen and back were cleansed and covered with sterile, dry gauze.

Operation.—Under ether anæsthesia both legs were operated for varicose veins after Schede's method. The abdomen was painted with three coats of tincture of iodine. An incision beginning three inches laterally from the spinous process of the first lumbar vertebra was made to traverse the anterior abdominal wall above the umbilicus, ending on the opposite side at a point analogous to the point of origin. The ends of this incision were joined by a second incision traversing the anterior abdominal wall a few inches above the pubis. The tissue composing the area thus outlined was removed from the deep fascia by the employment of a medium size amputating knife. The skin was closed as advised above. The line of suture was reinforced by silkworm tension sutures placed about three inches apart and including in their grasp the entire coats of the abdominal wall which were external to the deep fascia. These sutures were introduced one and one-half inches on either side of the suture line. Drainage was effected on either side of the body at the most dependent part, and the wound dressed with a large, moist boric acid dressing.

Subsequent History.—Schede operation healed without incident. The ulcer healed rapidly under scarlet-red ointment treatment.

During the three succeeding days following the operation the wound in the abdomen exuded a large amount of serum. Healing was *per primam*. The stitches were removed the ninth day after operation, and the wound supported by a collodion dressing. Patient walked out of the hospital the thirteenth day. During the time she was in bed she received no nourishment except water and three glasses of milk per day. Since her convalescence her diet has been carefully selected so that she has gained none of the 65 pounds which she lost during operation and starvation. She now claims to feel better when at work than she formerly did when at rest. The accompanying photographs depict her condition before and after operation.

BIBLIOGRAPHY.

[1] Demars and Marx: Le progrès médical, 5, iv, 1890.
[2] Kelly: Proc. Johns Hopkins Bulletin, vol. x, 1899, p. 197.
[3] Maylard: Brit. Med. Jour., Oct. 5, 1907, p. 895.
[4] Schulz: Mitt. a. d. Grenzegebieten d. Med. u. Chir., 1908, Bd. xviii, H. 5.
[5] Weinhold: Zentral. fur Gyn., Sept. 18, 1909, p. 1332.
[6] Kelly: Surg., Gyn., and Obst., March, 1910.
[7] Kelly: ANNALS OF SURG., March, 1911, p. 364.
[8] Ballard: Oklahoma State Jour., Nov., 1910.
[9] Oehlecker: Zentral. f. Chir., 1911, No. 11.
[10] Jolly: Berliner klinische Wochenschrift, July 17, 1911.

BOOK REVIEWS.

Vaginal Cœliotomy. By S. Wyllis Bandler, M.D., Adjunct Professor of Diseases of Women, New York Post-Graduate Medical School and Hospital. Octavo of 450 pages, with 148 illustrations. Philadelphia and London, W. B. Saunders Company, 1911.

The contents of this treatise are divided as follows: posterior vaginal cœliotomy; anterior vaginal cœliotomy; simple vaginal hysterectomy; indications and limitations in disease of adnexa; hysterectomy for myomata, submucous, deep interstitial tumors, and intraligamentous growths, hysterectomy and technic with indications for vaginal Cæsarean section.

The distinctive character of the work is the technic of the several operations discussed.

Relatively speaking, the book is neither dogmatic nor controversial, but the author points out in terse, plain language the reasons for his beliefs and methods. A tone of unobtrusive confidence pervades the book and impresses the reader that its author is speaking logically and from an experience which lends authority to its teachings. Concise and positive statement without circumlocution has enabled the writer to cover his ground in a comparatively small volume, and this fact adds immensely to its intrinsic value.

From the author's standpoint, the student and the operator are not left in doubt as to the technic of any operation, a fact not always easy to comprehend from didactic teaching. The art of the illustrators is carried to a high degree of perfection, so ideal that the reader sometimes questions whether they obscure the real.

After reading the book one is impressed with the conscious confidence and finality of its teachings, and admiration for the elegance of its diction.

Probably the subject of posterior vaginal cœliotomy comes first in point of value and ability. The usefulness of this procedure is of the highest importance in the ascites of peritoneal tuberculosis, and within certain limitations, paradoxical as it may appear, makes this form of tuberculosis easily curable. Again the author gives proper emphasis to its value in pelvic abscess. Whenever there may be uncertainty as to pus being in the peritoneal cavity or in the connective tissues lateral or posterior to the uterus, the procedure is equally wise and valuable.

Posterior cœliotomy for delivery of uterus and for removing ovarian cysts after Dührssen's method is warmly advocated.

While the author refers to Prior's most useful practice concerning this route in pelvic peritonitis, he dismisses it without further comment.

The subject of anterior vaginal cœliotomy is reviewed in quoting the views of German authorities, as Sanger, Zweifel, Dührssen, Kuster from 1888 to 1905, and in 1896 of Wertheim in devising vaginal fixation and shortening of the round ligaments.

He also quotes American authorities in the use of the anterior vaginal route, mentioning Boldt's operation for vaginal hysterectomy in 1887, and Goff's early adoption of this route for retroversion, retroflexion, and conservative operations on the adnexa, together with myomectomy for fibroids and operations for ectopic gestation.

He fortifies his claim to the superiority of anterior vaginal cœliotomy by Abel's acknowledgment that abdominal operations are easier than vaginal, who also states his early objections to the vaginal route were due to the fact that he did not understand its technic.

Notwithstanding his sincere, forceful advocacy of the advantages of anterior cœliotomy, he is equally positive in the reasons for which it is contraindicated. Among these are pregnancy, involvement of the appendix, of co-existing necessity of exploring the gall-bladder, large irregular fibroids, intraligamentous tumors, hæmatomas high up, etc.

While it is impossible to go into detail of other operations recommended, that of vaginal Cæsarean section is entitled to more than passing notice. "We are able," he says, after Dührssen, "with the aid of vaginal Cæsarean section in all normal pelves, and in such pelves whose conjugate is not less than 7.5 or 8 cm., at any period of pregnancy or labor even without pains and a completely closed cervix, to empty the uterus of its contents within a few minutes." This is radical obstetrical surgery not likely to come into general use by the average obstetrician, but with a field of usefulness well established and likely to be enlarged in proportion as the confidence and technical ability of the accoucheur expand.

In no part of the splendidly illustrated treatise are the various types in operative procedure better shown than in that of the vaginal Cæsarean section, or their utility better enforced.

One point in the technic of most of these operations which challenges a reason for its adoption is the nearness to the external os—at which the operator begins his inverted double incisions.

Finally it may be stated that while the clearness and logic of the writer cannot be gainsaid, it is hardly probable that its teaching in the main will in any great extent influence many operators to abandon their preference for an abdominal cœliotomy.

WALTER B. CHASE.

DIAGNOSTIC AND THERAPEUTIC TECHNIC. By ALBERT S. MORROW, M.D., Adjunct Professor of Surgery in the New York Polyclinic. W. B. Saunders Co., Philadelphia and London. 1911.

The author has incorporated in this volume a large number of the procedures employed in the various methods of diagnosis and also of treatment. While some of the methods detailed belong essentially to the domain of the specialist, the majority are practical procedures which the general practitioner, and especially the hospital interne, may be called upon to perform at any time.

The plan of the work comprises, first, a description of certain general diagnostic and therapeutic methods and, second, a description of those measures employed in the diagnosis and treatment of diseases affecting special regions and organs of the body.

All procedures are given in detail, thus obviating the necessity of referring back to other portions of the text; this, however, causes unavoidable repetition which does not in any way detract from the value of the book.

The illustrations are well drawn and profuse. The present work deserves especial recommendation for the general knowledge which it conveys.

INDUCED CELL-REPRODUCTION AND CANCER. By HUGH CAMPBELL ROSS, M.R.C.S., L.R.C.P., with the assistance of JOHN WESTLEY CROPPER, M.B., M.Sc., M.R.C.S., L.R.C.P. P. Blakiston's Son and Co., Philadelphia, 1911.

This is a study in the isolation of the chemical causes of normal and augmented, asymmetrical human cell-division. It is a fascinating story of research along new lines, dealing with the microscopic study of living cells. Incidentally one gets a view of the discouragement which British officials in India and Egypt throw in the way of the medical officers, to prevent their carrying on serious medical work. Dr. Ross has the courage to specify the Director-General of the Public Health Department of Egypt as such an official. This gentleman objected to Dr. Ross doing scientific work during his spare time, and also prevented his continuing his mosquito campaigns because he apparently did not believe in them; nor was Dr. Ross permitted to publish the results of his work. He left the Egypt service and continued his studies at the Royal Southern Hospital in Liverpool. His early discouragements at the hands of officialdom were not unlike those of his distinguished brother, Ronald Ross.

The investigators studied living cells in nutrient media under the microscope, and observed the means by which they could be made to divide and multiply at the will of the observer. With living cells in agar, they applied stains and various other substances, and observed their effect. As soon as a stain reached the nucleus of a cell it died.

Cells absorb all absorbable substances; they do not seem to have a selective power; they take out of the surrounding medium whatever is there, whether it is poisonous to them or not. Against this it may be offered that in therapeutics we observe that certain cells respond to certain substances and others do not. Ross and Cropper show that strychnine, for example, stimulates certain cells of the nervous system; but it is absorbed by all cells. It causes amœboid movements in leucocytes, but this gives rise to no gross symptom and passes unnoticed. A cell may absorb two substances, one of which is fatal to it and the other of which stimulates cell-division: it starts to divide and perishes in the process.

Experiments were made upon living blood-cells with aniline products, alkaloids, ptomaines, nucleins and glandular extracts. The proliferation of leucocytes and lymphocytes as a process of wound healing, it is shown, is caused by kreatin and xanthin. It has been supposed that the cell-proliferation of healing was due to the inherent propensity on the part of the cells to divide; but these observers have made it clear that division occurs when the cell has absorbed a definite amount of a chemical agent. Two of these agents are kreatin and xanthin, both of which are products of dead tissue, liberated by cells which have perished. When death of cells takes place, then the neighboring cells cannot resist the absorption of these substances, and they proliferate.

Another substance which stimulates proliferation is globin, a histone derived from hæmoglobin. Hæmoglobin, it is shown, has a distinct action in causing proliferation of the malarial parasite. The most rapidly growing cancer is melanotic sarcoma; and the development of sarcoma in the presence of blood-clot or destroyed cells is well known.

Concerning leucocytes, the authors say that for nearly a century and a half these cells have been observed in the blood, but no one has heretofore seen them in process of division. Now, if they are made to absorb certain chemical agents, they divide immediately; and, what is more, the rapidity of onset and the time occupied by each division varies directly with the quantity of the substance absorbed. Cell-division seems to be a physical phenomenon which can be measured in the case of each cell in proportions of the amount of the chemical auxetics absorbed by them. It can be reduced to a mathematic equation. A wound produces the remains of dead tissues, containing kreatin and xanthin, and proliferation of leucocytes occurs in the presence of these agents. The cell-proliferation in healing is proportionate to the extent of cellular death: much destruction, much repair.

These investigators go on to show this common chemical cause of cell-proliferation. The spermatozoa furnish the extractives which start proliferation in the ovum. Globin applied to chronic ulcers stimulates cell-proliferation greatly. An alkaloid of putrefaction, like choline, it is shown, must be the cause of lymphadenoma. In connection with this latter statement, it is interesting to note that Trousseau, in 1872, stated that lymphadenoma often follows on a focus of suppuration.

In experimenting with epithelial cells, it was found that they could not be made to live long *in vitro,* and experiments were difficult. It was assumed that, as cancer is peculiar to that period of life when the dead cells in the body increase, it is a phenomenon similar to those already discussed. Normal blood-serum was found to contain a body which has a restraining effect upon all division induced by auxetics. It was found that 1 c.c. of serum contained in 10 c.c. of gelatin, which also contained 1 c.c. of a 1 per cent. solution of choline, stopped the kinetic action of these in exciting amœboid movements. The experimenters tried to increase the amount of this inhibiting body in cancer patients by injecting an augmented auxetic combined with blood-serum. Six ounces of defibrinated sheep's blood were injected per rectum once daily. The serum contains the restraining body; and it was assumed that the red cells would be destroyed in the rectum, the hæmoglobin decomposed and the globin augmented by the action of bacteria. The products in this combination, being absorbed, it was thought, might act as a sort of vaccine.

This treatment the authors report having applied to several cases with good results in most of them. In the cases most carefully studied the tumor was made to disappear. The criticism should be offered that more cases should have been studied before publishing this report. It is of value in throwing light upon the cause of cell-proliferation. To these authors, perhaps, belongs the credit of having shown the cause of normal human cell-division, and possibly the cause of malignant cell-proliferation also. Whether the therapeutic measures which are suggested shall be of value remains to be seen. JAMES P. WARBASSE.

PRACTICAL CYSTOSCOPY. By PAUL M. PILCHER, A.M., M.D., Brooklyn, N. Y. 8vo, pp. 398. W. B. Saunders Co., Philadelphia and London.

A work on cystoscopy in English has been much needed. Dr. Pilcher's book supplies this need in a most satisfactory manner. The arrangement of the work is excellent, the text clear and concise, the illustrations, with liberal descriptive legend, are unusually instructive, and the work as a piece of bookmaking reflects credit upon the publishers.

The subject matter is divided into seven parts.

Part I deals with the types and construction of the various cystoscopes now in use, the electrical devices for supplying illumination, the technic of conducting the examination both in the male and female. The diagrams and illustrations to aid in interpreting objects seen through the different types of cystoscopes are excellent. There are many practical suggestions in regard to conducting the examination which are of much value to beginners. The technic of ureter catheterization is clearly described and illustrated. The difficulties encountered and the means at our command for overcoming these difficulties are well put.

Part II deals with the pathological conditions of the bladder as seen by the cystoscope. The various diseases are sufficiently described, and with the numerous excellent illustrations accompanying the description the different diseases should be recognized, one from the other, with less practical experience than was heretofore necessary.

Part III deals with diseases of the prostate. Here the method of recognizing the different diseases of this organ and the special forms of prostatic hypertrophy are described and illustrated. Diseases simulating prostatic diseases symptomatically are mentioned and their differential characteristics noted.

Part IV deals with diseases of the ureters. The methods of recognizing the diseases of these structures by means of the ureter catheters and the Röntgen rays are considered. The important information to be derived from distending the ureters with solutions of silver salt in connection with Röntgen ray examination might perhaps have received more consideration.

Part V is devoted to the consideration of the methods of determining the functional activity of the kidneys. The different tests are described and their relative value discussed. The exact details of technic are insufficient for those with no knowledge of the subject, and the student must consult original articles or other sources for this detail instruction, some of which original articles are designated by footnote.

Part VI considers the many different means of diagnosis of the various diseases of the kidney. Helpful illustrative cases are cited. The value and methods of local therapeutic measures are here considered. Semi-diagrammatic illustrations showing the pathological conditions and the appearances of ureteral orifices in the different diseases are most valuable.

Part VII describes briefly but sufficiently the important operative procedures which may be carried out by special cystoscopic instruments and devices.

Considering the work as a whole, Dr. Pilcher's book must be considered complete, well balanced in regard to the amount of space devoted to the different subjects, the arrangement excellent, and text and illustrations cannot be too highly commended. The index is most satisfactory. The book is typically American and has no superior in any language.

JOHN H. CUNNINGHAM, JR.

PLASTIC AND COSMETIC SURGERY. BY FREDERICK STRANGE KOLLE, M.D. New York, D. Appleton and Company, 1911.

The historic references in this book are of much interest. The author falls into the vernacular of the past and exclaims, "Withal, it is a noble, generous art, worthy of far more extensive use than it now enjoys."

In the pages of the book which are devoted to the author's special field, we find descriptions of plastic and cosmetic operations, which the surgeon may study, with satisfaction. The descriptions of the various incisions for plastic work are the best to be found in surgical literature. In all operations, the early removal of sutures is recommended in order to prevent scar. On the face the stitches are removed in from twenty-four to forty-eight hours.

The author's operation for reducing the size of the ear is ingenious. His operation for malposition of the auricle is effective.

The operations for hair-lip are fully described. Incisions to meet every possible condition are illustrated. The same is true of the operations for restoration of the lips.

The use of paraffin in prosthetic surgery is fully and well discussed in all its aspects. Twenty-two possible untoward results are described, and means for their prevention given. The technic of injections is minutely described. A complete classification of the conditions which may be remedied by paraffin prosthesis is presented, together with the technic for each operation. The large possibilities of this branch of surgery are made clear by this book, and its mastery made possible.

All of the methods of rhinoplasty, which are worthy of consideration are presented. The methods are well described and illustrated. Especial consideration is given to the securing of bony or cartilaginous supports for the soft plastic flaps. The methods suggested are most helpful. Cosmetic rhinoplasty is so well described that ethical surgery might hope to rescue this field from the quacks.

This book is of especial value to the surgeon who is skilled in the principles of his art. He can refer to it with satisfaction when seeking information on the plastic surgery of the head, face and neck. It is a useful work, and in its special field fills a place in surgical literature. J. P. WARBASSE.

COLLECTED PAPERS BY THE STAFF OF ST. MARY'S HOSPITAL, MAYO CLINIC. Volumes I and II. Octavo. Volume I, pages 668; Volume II, pages 633. W. B. Saunders Company, Philadelphia, Pa., 1911.

These two fine volumes present the papers and reports made by the staff of St. Mary's Hospital, of Rochester, Minn., from

1905 to 1911. Naturally the great bulk of the volumes is from the pens of the two senior members of the staff, Drs. William J. and Charles H. Mayo. In Volume I, out of seventy-three papers, Dr. William J. is to be credited with fifteen papers, and Dr. Charles H., with twelve. In Volume II, of sixty-three papers, Dr. William J. is to be credited with twelve and Dr. Charles H. with seven. When one observes that Volume II is the output from this clinic of a single year, the growth in the activity of the work is especially noticeable.

These papers have been read before various medical societies and are brought together in their present form for convenience of reference. More than that, however, in their collected form they constitute a magnificent monument to the scope of the work carried on in the Mayo Clinic, and to the industry, breadth and progressiveness which characterize that clinic.

The volumes are published with full Indices, both of authors and of subjects, so that reference to their contents is greatly facilitated. They are abundantly illustrated.

In running through these volumes one cannot fail to feel a certain personal note significant of the relations of the directors of this clinic to their whole work. These volumes form the beginning of a personal surgery of the highest character and of the greatest value. It is to be hoped that for many years to come successive volumes of the same character will appear.

THE TREATMENT OF FRACTURES, With Notes Upon a Few Common Dislocations. By CHARLES LOCKE SCUDDER, M.D. Seventh Edition, Revised and Enlarged. Octavo. Pages 708. W. B. Saunders Company, Philadelphia, Pa., 1911.

The successive editions of this book during the past ten years have received notice from time to time in the ANNALS OF SURGERY. It has been very interesting to note the steady growth in the scope and quality of the book. Its dominant note still remains that of treatment, and the number and character of the illustrations still remain a most attractive and valuable characteristic. The author has a genius for illustration, so that in turning over the pages of the book one seems to be in the presence of the author, demonstrating the particular condition under consideration. In the present edition it is to be noted that new material has been added, especially upon fractures of the skull, fractures of the spine, fractures of the neck of the femur, and injuries to the lower end of the tibia. A chapter on the operative treatment of fractures has also been added. The attitude toward the operative treatment of fractures by the author is a very properly conservative one, such as every surgeon believes in, "that operative treatment of fractures is desirable, provided the indications for operation are clear." "The majority of simple or closed fractures can be satisfactorily treated by non-operative methods. Each individual case should be judged on its own merits." "It must ever be kept in mind that a very definite indication for operation must be present before an individual case is submitted to the additional risk of incision and direct fixation." These ideas we think will meet with general acceptance among surgeons. In their application, however, naturally there will be differences due to the different experiences, opportunities, and aptitudes of different surgeons.

Dr. Scudder's book has grown until it is no longer merely a hand-book, but it has become a portly volume of reference and occupies a worthy place among the very best books in its special field. We have put it on our shelf by the side of Hamilton, Stimson, Gurlt, and Hoffa. LEWIS S. PILCHER.

CORRESPONDENCE.

NEEDLES FOR ARTERIAL ANASTOMOSIS.

EDITOR, ANNALS OF SURGERY:

Will you be so good as to call attention to an error in printing in the article "The Technic of End-to-End Arterial Anastomosis?" On page 489, the line "needles, No. 6 Kirby sharps" should read: "needles, No. 16 Kirby sharps."

Yours truly,

Boston, Mass. ALBERT EHRENFRIED.

ANNALS OF SURGERY

VOL. LIV DECEMBER, 1911 No. 6

ORIGINAL MEMOIRS.

THE VALUE OF THE LEUCOCYTE COUNT IN ACUTE SURGICAL DISEASES.

BY HERBERT W. HEWITT, M.D.,

OF DETROIT, MICH.

WITHIN the last decade leucocyte counting in acute surgical diseases has acquired a new meaning, due largely to the recognition of the value of the differential count. For many years total counts only were made, and these yielded but little information, as their significance was not well understood. An ordinary furuncle might produce a high count, while a severe general peritonitis might reveal a leucopænia, and these facts could not be satisfactorily explained. Since a more complete blood picture has been utilized in the study of this class of diseases, valuable information as to the diagnosis and prognosis has been made available. The limitations of all laboratory work, however, must be recognized. The laboratory alone cannot, save in exceptional instances, make a diagnosis for the physician. The clinical findings must be correlated with those from the laboratory, and this is especially true of blood work in acute surgical diseases. It is necessary to carefully exclude all other conditions which might cause a departure from the normal.

For the purpose of this paper it is essential to have, as a working basis, an average normal, not only of the total number of white cells, but also of the polymorphonuclear cells

As the polymorphonuclear cells are principally affected in inflammatory diseases, they alone of the various types will be considered. Various writers give the average number of leucocytes considered normal from 6000 to 10,000, and the average normal percentage of polymorphonuclears from 60 to 80 as follows:

Sondern	6,700	68 per cent.
Von Limbeck	8,500	70–80 per cent.
Da Costa	7,500	60–75 per cent.
Gibson	10,000	75 per cent.
Hayem	6,000	
Tumas	6,200	
Graeber-Reineke	7,242	
Boeckner-Halla	7,533	
Thoma	8,687	

If 10,000 is taken as the maximum number for the total count and 75 per cent. as the highest percentage for polymorphonuclears, the average normal will probably not be too low. The total count of itself is of little value, as it is influenced by many factors. These may be classified as follows:

A. Physiological leucocytosis: (1) leucocytosis of new born; (2) leucocytosis of digestion; (3) leucocytosis of pregnancy; (4) leucocytosis after parturition; (5) leucocytosis of violent exercise; (6) leucocytosis of cold baths and massage; (7) terminal leucocytosis.

B. Pathological leucocytosis: (1) post-hemorrhagic; (2) inflammatory; (3) toxic; (4) malignant disease; (5) due to therapeutic and experimental influences.

Then, too, in severe infections which are poorly resisted, a low total count is frequently observed; while in mild infections well borne, a high total count may be found.

The differential count, on the other hand, is of much greater value, since this is, as a rule, uninfluenced by physiological factors, and the changes due to the pathological conditions are more definitely defined. When both total and differential counts are taken and the relation each bears to the other is considered, the assistance rendered in the diagnosis and prognosis of the disease in question possesses a value vastly greater than either of the less complete and unrelated observations.

Surgery deals with general rules, and not with absolutisms, and there are exceptions to nearly all rules. The following statements, however, may be considered as general rules:

1. The total count is an index of the patient's resistance to the infecting organism.

2. The relative polymorphonuclear count is an index of the degree of, or the severity of, the infection.

3. If we have a relative polymorphonuclear count ranging between 75 per cent. and 80 per cent., infection is probable; if between 80 per cent. and 85 per cent, infection is usually found; if above 85 per cent., infection is almost invariably encountered, and this regardless of the total number of leucocytes. In fact, some laboratory workers do not make use of the total count at all, but depend for diagnosis entirely upon the differential count.

A few points can usually be decided by reference to both counts, namely:

(a) bodily resistance, whether high or low; (b) infection, whether severe or mild; (c) infection whether well borne or poorly resisted; (d) infection, whether circumscribed or uncircumscribed (*e.g.*, appendiceal abscess).

Gibson[1], of New York City, speaks of the relative disproportion between the differential and total counts, and considers that "bodily resistance is more clearly defined by this disproportion than by any other means at our command, and that of all methods of blood examination, this is the most valuable, both from a stand-point of diagnosis and prognosis."

Dr. Gibson has suggested the use of the chart in order to more clearly show this disproportion. He assumes 10,000 as the maximum normal for the total number of leucocytes and 75 per cent. as the highest percentage of polymorphonuclear cells to be considered normal. He further assumes that, "In inflammatory lesions which are well borne, the polymorphonuclear cells are increased 1 per cent. above 75 per cent. for every 1000 of the total leucocytes above 10,000." Upon this basis he has made some interesting observations.

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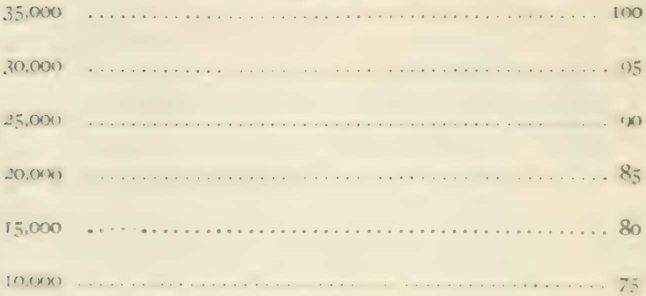
[1] The Value of the Differential Count in Acute Surgical Diseases, ANNALS OF SURGERY, 1906, pg. 485.

Chart I shows a typical Gibson chart.

CHART I.



An infection which is well resisted will show a parallel line, or else a line the obliquity of which will run toward the leucocyte side of the chart (see Chart II.) If the line runs about level, whether high or low, it indicates that a lesion, whether severe or not, is well borne and therefore of good prognosis.

The obliquity of the lines determine the prognosis in a given case.

Chart II shows the count in a case of acute suppurative appendicitis placed upon the Gibson chart. In this case there is a slightly falling line, but it shows that the infection is well resisted. Patient recovered; infection, colon bacillus.

CHART II (Case No. 66).

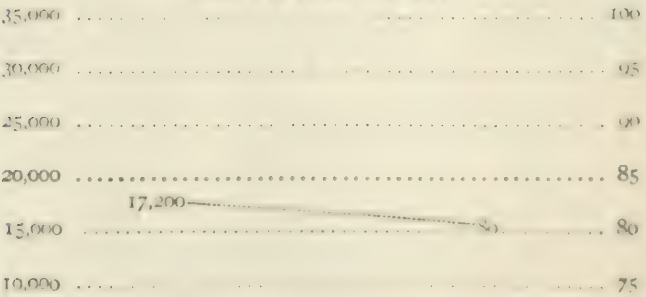
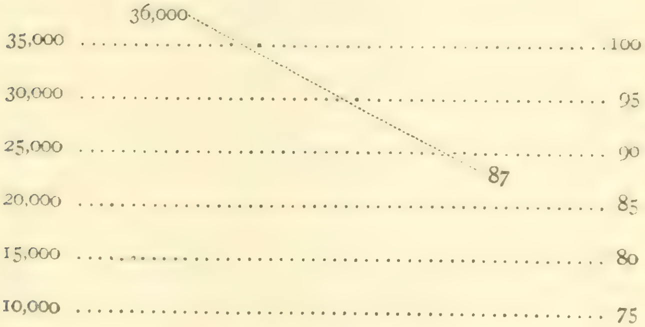


Chart III shows a case of pelvic abscess. We have here a favorable condition for operation, as the line runs from the leucocyte side downward with a marked degree of obliquity. Result, recovery, with no unfavorable symptoms.

CHART III (Case No. 80).



Gibson states that all of his fatal cases showed a rising line. In our series, four revealed a slight falling line. It is important in this connection to take into consideration, as suggested by Fowler,[2] the duration of the disease, because we know that where infection is severe resistance is in time overcome, and then our counts will be of little value.

Chart IV shows a case of general peritonitis (diagnosis confirmed by autopsy). The very low total count and the marked deviation upward of the line toward the polymorphonuclear side of the chart make this a case where the prognosis is exceptionally unfavorable.

I wish to report 100 cases taken from Dr. Metcalf's and my own private records. The cases are all of the acute inflammatory type, and all have been brought either to operation or autopsy, so that the diagnosis has been either confirmed or disproven. In a number of cases many counts have been made, but the count made immediately before the operation has been the one used in this series. No one will deny that repeated counts are of much greater value in diagnosis than one isolated count. This point is especially emphasized by Gibson: "The importance of a disproportionate increase of polymorphonuclear cells, particularly if progressive, cannot be overestimated, and those wilfully disregarding such evidence are perhaps not exhausting all resources available for diagnosis."

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[2] The Relation of Appendicitis to the Leucocyte Count, Surgery, Gynæcology and Obstetrics, Sept., 1908.

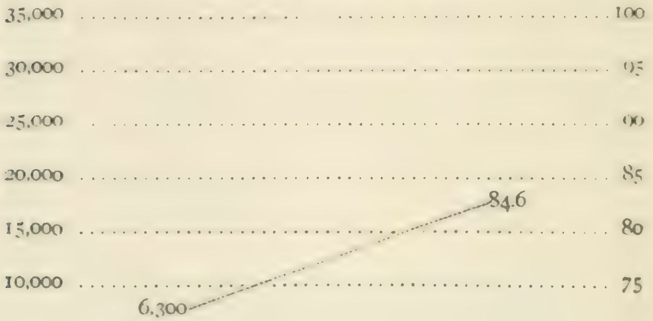


CHART IV (Case No. 42).

The cases may be classified as follows:

Acute catarrhal appendicitis	13
Acute suppurative appendicitis (circumscribed)	10
Acute suppurative appendicitis (uncircumscribed)	9
Acute perforative or gangrenous appendicitis	6
Acute pyosalpinx	12
Pelvic abscess	18
Puerperal sepsis	13
Pelvic lymphatic infection	3
General peritonitis	5
Acute cholecystitis	4
Stitch abscess	3
Abscess of kidney	1
Abscess of parotid gland	1
Subphrenic abscess	1
Infected ectopic gestation (ruptured)	1
Total	100

The appendicitis cases are interesting, and we have come to depend on the leucocyte count as an important factor in the diagnosis and prognosis of this disease.

Thirteen catarrhal cases show:

Average total count	17,907	Average polymorphonuclear	.83%
Highest total count	33,000	Highest polymorphonuclear	.90%
Lowest total count	8,900	Lowest polymorphonuclear	.73%

Six cases of perforative and gangrenous:

Average total count	19,517	Average polymorphonuclear	.89.16%
Highest total count	30,000	Highest polymorphonuclear	.90%
Lowest total count	13,500	Lowest polymorphonuclear	.83%

Nine cases of suppurative (uncircumscribed):

Average total count	18,051	Average polymorphonuclear	.89.8%
Highest total count	27,700	Highest polymorphonuclear	.98.6%
Lowest total count	5,900	Lowest polymorphonuclear	.81%

Ten of circumscribed abscess:

Average total count	19,049	Average polymorphonuclear	.86.75%
Highest total count	36,200	Highest polymorphonuclear	.97%
Lowest total count	9,100	Lowest polymorphonuclear	.78%

Closely allied to this group are the cases of acute pyosalpinx, puerperal sepsis, and pelvic abscess.

Of pyosalpinx, there are twelve cases with the following data:

Average total count	15,133	Average polymorphonuclear	.83.3%
Highest total count	31,660	Highest polymorphonuclear	.89%
Lowest total count	6,300	Lowest polymorphonuclear	.67%

Of puerperal sepsis, thirteen cases:

Average total count	16,315	Average polymorphonuclear	.81.5%
Highest total count	26,200	Highest polymorphonuclear	.98%
Lowest total count	12,300	Lowest polymorphonuclear	.76%

Of pelvic abscess, eighteen cases:

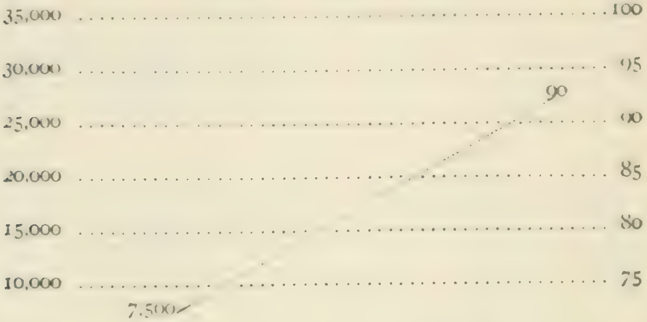
Average total count	20,005	Average polymorphonuclear	.83.3%
Highest total count	31,000	Highest polymorphonuclear	.91%
Lowest total count	10,200	Lowest polymorphonuclear	.70%

Four cases of cholecystitis show averages very high:

Average total count	20,055	Average polymorphonuclear	.92.4%
Highest total count	33,920	Highest polymorphonuclear	.97%
Lowest total count	7,500	Lowest polymorphonuclear	.90%

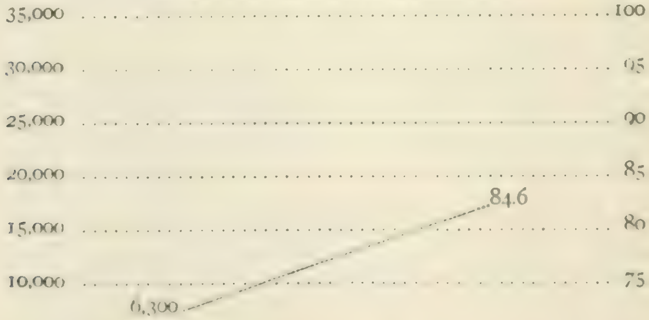
The case of acute suppurative cholecystitis (Chart V) is the only one in our series that revealed such a sharp (15°) rising line on the Gibson chart, and still recovered. This was a case of a woman over seventy years of age, who was operated upon within two days after symptoms appeared. This count indicates the low vitality of our patient, and an infection of marked severity.

Chart V (Case No. *22*).



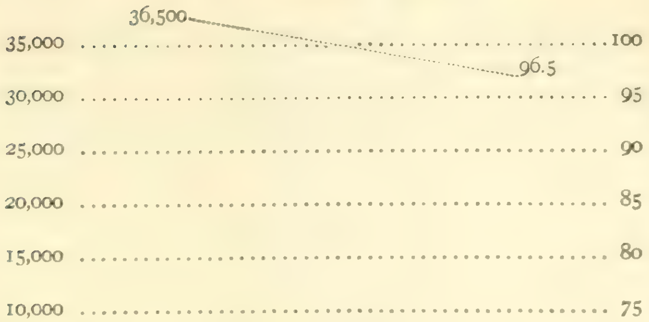
The five cases of general peritonitis all died, three showing a rising line and two a falling line, as shown in the accompanying charts.

Case No. 42, General Peritonitis.



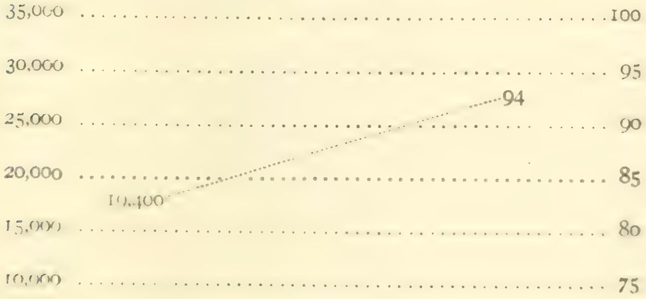
Three cases of stitch abscess are interesting to illustrate what a marked leucocytosis a small stitch abscess is capable of producing: Case 17, total count 16,200, polymorphonuclear 85.5 per cent.; Case 16, total count 25,000, polymorphonuclear 87 per

CASE NO. 55, GENERAL PERITONITIS.



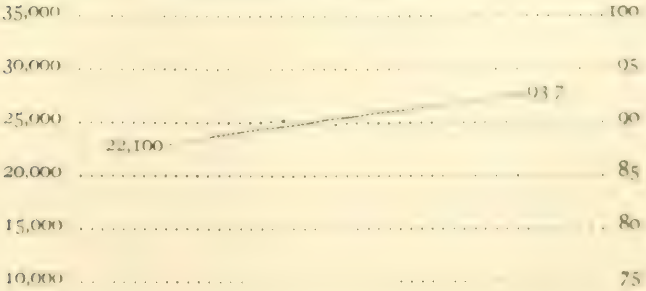
Fatal case, infection mixed, streptococcus predominating. Infection existing over short period of time only.

CASE NO. 70, GENERAL PERITONITIS.



Fatal case.

CASE NO. 84, GENERAL PERITONITIS.



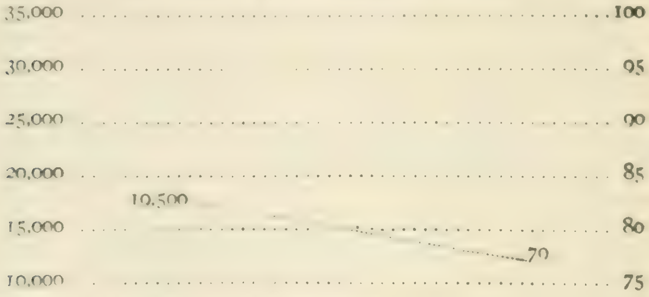
Fatal case

cent.; Case 100, total count 23,400, polymorphonuclear 93.5 per cent.

The remaining cases may be tabulated as follows:

Pelvic lymphatic infection, three cases: Case 82, total count 22,100, polymorphonuclear 91 per cent.; Case 49, total count 11,200, polymorphonuclear 81.5 per cent.; Case 34, total count 7,800, polymorphonuclear 75 per cent.

Case No. 89. General Peritonitis.



Fatal case. Long continued infection.

Ruptured ectopic gestation (infected), one case: Case 77, total count 22,000, polymorphonuclear 87 per cent.

Subphrenic abscess, one case: Case 96, total count 35,000, polymorphonuclear 79 per cent.

Abscess kidney, one case: Case 48, total count 35,890, polymorphonuclear 91.5 per cent.

Abscess of parotid gland, one case: Case 50, total count 12,200, polymorphonuclear 91 per cent.

Our averages when classified according to the polymorphonuclear count may be arranged in the following order:

	Total	Polymorphonuclear
Pelvic lymphatic infection	13,866	82.3 per cent.
Acute catarrhal appendicitis	17,907	83 per cent.
Pelvic abscess	20,005	83 per cent.
Acute pyosalpinx	14,636	83.3 per cent.
Appendiceal abscess (circumscribed)	19,089	85.75 per cent.
Appendiceal abscess (uncircumscribed)	18,175	86.4 per cent.
Puerperal sepsis	16,315	86.9 per cent
Stitch abscess	21,733	87.6 per cent.

	Total	Polymorphonuclear
Gangrenous and perforative appendicitis	19,516	89.1 per cent.
General peritonitis	20,564	89.5 per cent.
Acute cholecystitis	20,055	92.3 per cent.

It seems to the writer that these averages are significant. Excluding the counts in stitch abscess and puerperal sepsis, the following points are noted. In acute inflammatory diseases in the pelvis the polymorphonuclear counts are low. When we approach the appendiceal region the count is higher, but when we reach the "attic" of the abdomen our records show very marked increase in both total and polymorphonuclear counts.

A question that arises at this time is: "Can we place the percentage of polymorphonuclear cells at a certain number below which we do not expect to find infection?"

Sondern[3] has the following to say in this respect: "A relative percentage of polymorphonuclear cells below 70 with an inflammatory leucocytosis of any degree excludes the presence of pus or gangrene at the time the blood examination is made, and usually indicates good bodily resistance toward infection." Gibson cited three pus cases with polymorphonuclear counts below 70 per cent., and in my series I had one case (Case 27, acute pyosalpinx with adhesions and small pockets of pus among adhesions).

I do not believe that between 65 per cent. and 80 per cent. we can state with any degree of accuracy that the count *per se* means the presence of infection.

The writer believes that in acute inflammatory surgical diseases repeated counts at frequent intervals should be made, and if the polymorphonuclear percentage rises while the total number remains stationary or falls, immediate operation should be insisted upon.

In some cases we found that the leucocyte count did not help us in making a diagnosis, and in these cases we have disregarded the blood findings entirely and depended upon the history and physical signs, but in cases where the count has been positive its value could not be easily underestimated.

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[3] The Present Status of Blood Examinations, Medical Record, vol lxvii, pp 452-455

Leucocyte counts are sometimes valuable for their negative findings, *e.g.*, they are frequently of assistance in making a diagnosis between a small ovarian cystoma with a twisted pedicle and a pyosalpinx or appendicitis. Dr. Metcalf operated upon a case illustrating this. A very large woman with thick abdominal wall was suddenly seized with pain over McBurney's point and vomited. Tension of muscle and tenderness were present in the right lower quadrant of abdomen. Temperature and pulse were normal. Vaginal examination revealed nothing positive. Diagnosis, small ovarian cyst with a twisted pedicle, right side, or acute appendicitis. Blood count revealed 8590 leucocytes with 62 per cent. polymorphonuclears. Diagnosis after blood count, ovarian cyst with twisted pedicle, and this was confirmed by laparotomy.

The counts enumerated in this paper were made by Drs. Safford, Torrey, and myself, and a uniform technic was followed.

I wish to acknowledge my indebtedness to Dr. Metcalf for the perusal of his case records, and to Drs. Safford and Torrey for assistance rendered.

CONCLUSIONS.

1. The laboratory findings must be correlated with the clinical to be of any value at all.

2. The total count alone is insufficient.

3. The differential count, *per se,* is of value in diagnosis, but of little value in prognosis.

4. The total and differential counts, when taken together and correlated with the clinical findings, are frequently of great value both in diagnosis and prognosis.

5. No definite percentage of polymorphonuclear cells can be taken to positively indicate infection. If we have a percentage of between 75 and 80 of polymorphonuclear cells,

infection is probable; if we have a percentage of between 80 and 85, infection is usually found; if we have a percentage above 85, infection is almost invariably encountered.

6. The negative value of the count is sometimes very useful in diagnosis.

7. The duration of the infection must be taken into consideration.

Counts are more positively diagnostic when taken early in the course of an acute surgical disease. Infection will frequently, when of long duration, overcome the patient's resistance and so vitiate the value of the count.

THE TRANSPLANTATION OF FREE FLAPS OF FASCIA.

AN EXPERIMENTAL STUDY

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INTRODUCTION.—For some time I have been interested in the methods brought forward for replacing and for reinforcing weakened or defective tissues, and while some of the methods are admirable, all are limited in their application. It seemed worth while to search for a material which would accomplish the same purpose but would have a wider field of usefulness.

In looking about for some suitable tissue in the body which was easily obtainable, which had considerable strength, and at the same time was sufficiently flexible for any desired need, I was led to try the experimental transplantation of free flaps of fascia.

After proceeding with the experiments for some time I found that some excellent work had already been done along this line.[1] However, my results were sufficiently suggestive to warrant a report on the subject, in order to again call attention to this promising surgical procedure.

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[1] Kirschner, M.: Ueber freie Sehnen-und Fascien. Transplantation, Beitr. z. klin. Chir., 1909, lxv, 472.

Günther: Ueber Duraplastik: eine klinisch-experimentelle Studie, Beitr. z klin. Chir., 1910, lxix, 740.

Hohmeier: Ueber ein neues Verfahren zur Deckung von Trachealdefekten, München. med. Wchschr., 1911, Bd. lviii, 948.

Since this paper was handed in for publication the following experimental-clinical articles have appeared. They will be considered fully in another report.

Hohmeier, F: Experimente über Verschluss von Wunden und ueber-

Sixty-two experiments were done on 39 dogs. Ether anæsthesia was used in each experiment.

Technic.—The part was shaved, washed with green soap and water, then with alcohol and ether. After the skin was thoroughly dry it was painted with tincture of iodine 2.5 per cent. The iodine solution was also freely used in the open wounds and after suture of the skin.

Fine black silk was the ligature and suture material used throughout. The wounds were closed in layers wherever possible. The skin was closed in every instance with the button-hole stitch.

Dry sterile gauze secured by a bandage was used wherever dressings were applied.

The fascia was obtained, for the most part, from the thigh, the iliotibial band of the fascia lata being the most satisfactory portion to work with, as it is easily separated from the underlying tissues. In a few instances the strong abdominal fascia was employed.

The fascia was transplanted in both single and double layers and in one or two instances was twisted.

In each experiment where adhesions were not desired the fascia lata (iliotibial band) was placed with the inner or muscle surface exposed. For example, when a flap of fascia was placed in a peritoneal defect, the muscle or smooth side was turned toward the peritoneal cavity, and it was found that dense adhesions were less likely to occur than when the outer side was turned toward the cavity.

In this series, unless otherwise stated, the fascia was transplanted into the same animal from which it was taken.

An attempt was made to place free flaps of fascia on the various tissues, in order to test its vitality and obtain an idea of its possibilities for clinical use.

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brückung von Defecten Schleimhauttragender Korpercanale und-hohlen durch freie auto-plastic, Arch. f. klin. Chir., 1911, 345.

König, F.: Newe Wege der plastischen Chirurgie (Verschluss und Ueberbrückung), Arch. f. klin. Chir., 1911, 326.

Lewis, D. and Davis, C. B.: Experimental Direct Transplantation of Tendon and Fascia, J. Amer. Med. Assn., lvii, 1911, 540.

Experiments.—For convenience I have divided the series into eight groups. To economize space I will only report a few of the typical experiments in each group.

Group I.—Transplantation of Free Fascia into Subcutaneous Tissue, on Fat; on Muscle; Periosteum, on Naked Bone; Cartilage, Tendons and Ligaments.

Experiment 6.—Male, black mongrel; about nine months old. *Operation,* November 22, 1910: A piece of fascia lata was sutured in the subcutaneous tissue of the chest wall. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

February 23: Distemper. The animal was sacrificed. *Autopsy.*—The fascia was somewhat thickened but otherwise it seemed normal. It was strong and tough.

Histology.[2]—Microscopic examination showed apparently normal fascia with fibres and nuclei clearly stained. No degeneration.

Experiment 7.—Female, white fox terrier; about six months old. *Operation,* November 28, 1910: The sartorius muscle was exposed and a broad band of fascia lata was sutured snugly around it. The wound was closed in the usual manner. No dressing. Condition on leaving the table excellent. *Per primam* healing.

January 16, 1911: Animal sacrificed. *Autopsy.*—The fascia was somewhat thickened but otherwise it seemed normal. The fascia band could be easily stripped from the muscle.

Histology.—Microscopic examination: the sections showed normal fascia with no signs of degeneration.

Experiment 8.—Female, tan mongrel; about six months old. November 29, 1910, a flap of fascia lata was removed from the thigh and wrapped in moist salt gauze and then placed in the ice box in a sterile jar.

Operation.—December 1, 1910: The fascia which was placed in the ice box forty-eight hours ago was sutured on the ribs, under the muscle. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

January 24, 1911: Animal sacrificed. *Autopsy.*—The fascia was thickened but otherwise it seemed normal. It was movable on the ribs.

Histology.—Microscopic examination: the sections showed normal fascia with clearly stained nuclei and fibres.

Experiment 9.—Male, black and white fox terrier; about two years old. *Operation,* December 1, 1910: The right femur was exposed and the periosteum was stripped back for about 2 cm. Into this defect a band of fascia lata was sutured around the bone. The wound was closed in the usual manner. No dressing. Condition on leaving the table excellent. *Per primam* healing.

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[2] I take this opportunity of thanking Dr. C. D. Deming for assistance in the histological examinations.

December 27: Death from pneumonia. *Autopsy.*—The band of fascia was somewhat thickened and was intimately blended with the periosteum on either side. The structure of the fascia could be plainly seen.

Histology.—Microscopic examination: the sections showed normal fascia with no signs of degeneration.

Experiment 43.—Female, white mongrel; about two years old. *Operation,* March 14, 1911: The trachea was exposed and a large flap of fascia was sutured on it. This fascia had been removed from another animal on February 7, 1911, and had been in cold storage since that date. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

April 10: Death from distemper. *Autopsy.*—The fascia was somewhat thickened but otherwise it seemed normal. It was closely adherent along the margins and seemed to blend with the tissues on the surface of the trachea.

Histology.—Microscopic examination: the sections showed normal, well-nourished fascia.

Comment.—In this group free fascia flaps were successfully transplanted into the subcutaneous tissue, into fat, on muscle, periosteum, bone, cartilage, tendons, and ligaments.

Microscopic examination of the specimens showed that the fascia retained its own structure after transplantation and was apparently healthy and well nourished. This was true even after being kept in cold storage for 35 days and then transplanted into another animal.

The clinical uses suggested by these experiments are of considerable importance, and cover a wide field.

Group II.—Transplantation of Free Fascia into Tendon and Muscle Defects.

Experiment 16.—Male, black mongrel, about six months old. *Operation,* December 19, 1910: The right tendo Achillis was exposed and a section about 2.5 cm. long was removed. The stumps were held in position by a strong tension suture, and then a flap of fascia lata was placed in the defect so as to surround the stumps like a tube. This tube was then drawn tight and the ends were securely sutured around the stumps. The tension suture was cut and the dead spaces obliterated. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

March 7, 1911: Distemper. Sacrificed. The animal had been very active and had no limp. It was impossible to tell which leg had been operated on without close inspection. *Autopsy.*—The replaced tendon was thicker than normal but seemed strong and satisfactory in every way (Fig. 1).

Histology.—Microscopic examination: cross section of the new tendo

Achillis showed normal staining fascia which was folded on itself. Surrounding the fascia was connective tissue, which caused the apparent thickening of the new tendon.

EXPERIMENT 20.—Male, white fox terrier, about four months old. *Operation*, January 3, 1911: The sartorius muscle was exposed and a section about 2.5 cm. long was removed. The muscle ends were held in position and a flap of fascia lata was sutured into the defect surrounding the muscle stumps by a tube of fascia. The dead space was obliterated and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

February 1: Death from pneumonia. Since the healing the animal had been very active and no difference could be detected in the gait. *Autopsy.*—The fascia was firmly united with the muscle ends (Fig. 2).

Histology.—Microscopic examination: the sections showed fascia with fibres and nuclei clearly stained.

Comment.—This group shows that muscle and tendon defects may be bridged by free flaps of fascia. Muscle defects may be bridged by means of fascia flaps and thus a certain amount of the muscle function saved. The fascia united firmly with the muscle ends and formed a strong symmetrical band between them.

The use of fascia flaps to replace tendons is of especial importance and most promising clinically. While it is a well-known fact that free tendon transplantation can be successfully done, it must be borne in mind that it is often difficult to secure either long or short pieces of tendon without doing considerable damage.

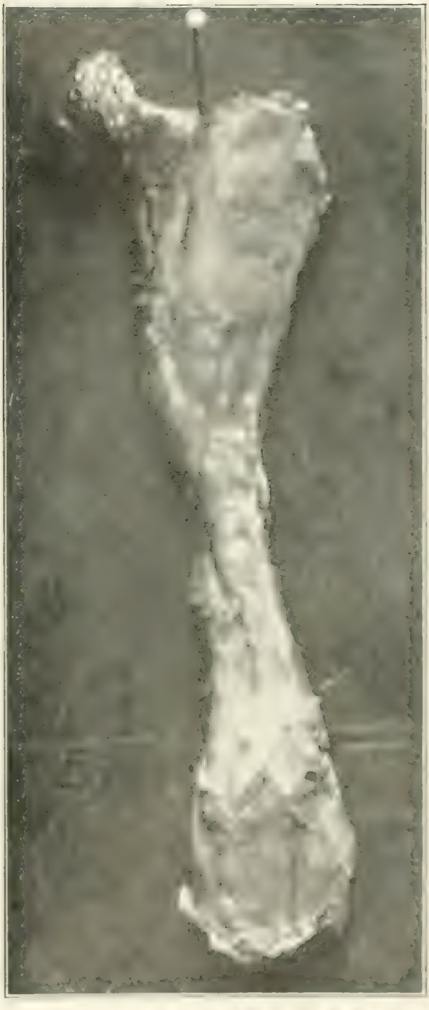
There are large amounts of fascia available in the body which can be secured without damage to any other working part. Thus tendons of any desired length might be made from strips of the iliotibial band of the fascia lata.

Experimentally the tendons made of folded strips of fascia are not liable to adhere to surrounding tissues. Fascia flaps might also be used to prevent tendons from being caught in scar tissue. The final results after replacing tendons with this material are more satisfactory than with any foreign material or transplantable tissue with which I am familiar.

Group III.—Transplantation of Free Fascia Around Vessels and Nerves.

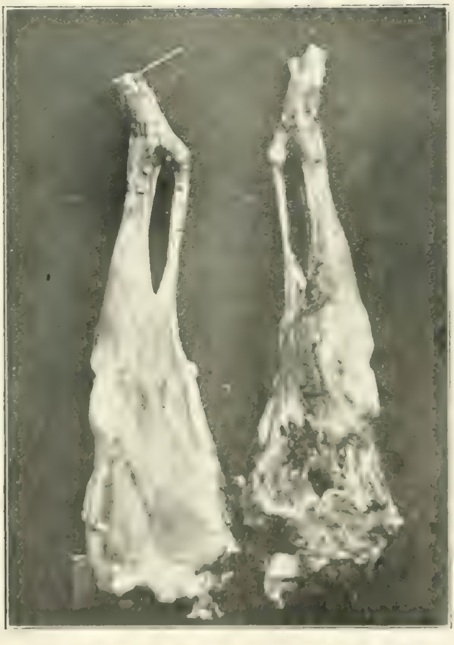
EXPERIMENT 33.—Female, black and yellow mongrel, about one year old. *Operation*, February 14, 1911: The right jugular vein was dis-

Fig. 2

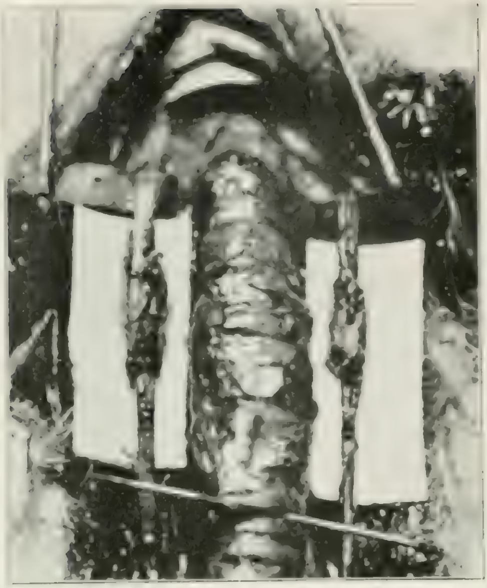


Experiment [illegible].—Fascia replacing defect in [illegible] femoris muscle. Operation, December 17, 1910. Specimen removed January 13, 1911. The thick muscle ends are seen, and connecting them is the tendon which resembled closely in life.

Fig. 1.

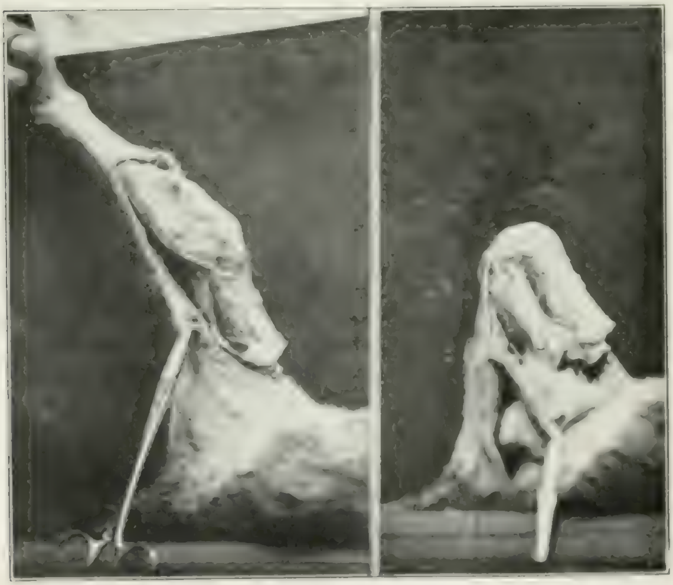


Experiment 17.—Fascia to replace tendo Achillis. Operation, December 19, 1910. Specimen removed March 7, 1911. Comparison of new and normal tendons. The new tendon is thicker than the normal.



Experiment [illegible].—Fascia around vessels and on trachea. Operation, March 14, 1911. Specimen removed April 17, 1911. On the right carotid can be seen a flap of fascia which was transplanted immediately from the same animal. On the left carotid and trachea are flaps of fascia from another animal which had been in cold storage for 35 days.

FIG. 4.



Experiment [illegible].—Fascia filling defect made by removal of patella. Operation, January [illegible]. Specimen removed February [illegible]. Note thickness of extensor and [illegible]. The fascia has become firmly healed [illegible].

sected out and a flap of fascia lata was wrapped about it. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

March 3: Death from pneumonia. *Autopsy.*—The fascia was thickened but otherwise seemed normal. It was quite adherent to the vessel wall. The lumen of the vessel was not encroached upon.

Histology.—Microscopic examination: the sections showed the structure of the vessel to be normal. It was surrounded by a band of fascia which was apparently well nourished and showed no signs of degeneration.

Experiment 41.—Female, yellow and white mongrel, about one year old. *Operation,* March 14, 1911: Both common carotid arteries were exposed. Around the right carotid a piece of fascia lata was sutured, which had just been removed from the right thigh. Around the left carotid was sutured a piece of fascia which had been removed from another animal on February 7, 1911, and had been in cold storage since that date. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

April 10: Death from pneumonia. *Autopsy.*—The fascia on both carotids was thickened, but otherwise seemed normal The appearance of the two specimens was the same. The fascia was quite adherent to the vessels but could be stripped off. The lumen of the vessels was not encroached upon (Fig. 3).

Histology.—Microscopic examination: the sections showed apparently normal fascia in both instances. No signs of degeneration.

Experiment 44.—Male, black and white fox terrier, about one year old. *Operation,* March 21, 1911: The right sciatic nerve was exposed and a flap of fascia lata was sutured around it. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing. Gait unaffected.

April 20: Distemper, animal sacrificed. *Autopsy.*—The fascia was thickened but otherwise seemed normal. It could be moved on the nerve to a slight degree. There was no constriction of the calibre of the nerve.

Histology.—Microscopic examination: the sections showed a normal nerve surrounded by well-nourished, apparently normal fascia.

Comment.—This group shows that free flaps of fascia may be successfully transplanted around arteries, veins, and nerves, without in any way interfering with the lumen of the vessels or compressing the nerves.

Clinically, fascia flaps might be of use in protecting suture lines in vessel surgery and in reinforcing weakened areas in vessel walls. The site of nerve plastic operations might be surrounded and protected by such flaps. It might also be of use in protecting a nerve after it was freed from callus or scar tissue.

Group IV.—Transplantation of Free Fascia into Joints and for Suturing Fractured Bones.

Experiment 22.—Female, yellow mongrel, about six months old. *Operation*, January 9, 1911: The left patella was removed and a piece of fascia lata was substituted for it. The fascia was folded on itself so that its inner smooth surface was next to the joint, and also under the skin. It was sutured to the capsule and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

February 2: Pneumonia, animal sacrificed. The joint was freely movable and as far as could be seen had been as serviceable as the normal knee (Fig. 4). *Autopsy*.—The fascia was easily separated from the skin. It had adhered firmly to the joint capsule. On opening the joint the surface of the fascia was perfectly smooth. There were no adhesions. The fascia was slightly thickened.

Histology.—Microscopic examination: the sections showed a double thickness of apparently normal fascia. The staining of fibres and nuclei was well marked (Fig. 5).

Experiment 29.—Female, white fox terrier, about eight months old. *Operation*, February 6, 1911: The right knee-joint was opened and the entire articular cartilage was removed as thoroughly as possible. Then a piece of fascia lata was inserted and sutured over the denuded portion of the femur and well up under the patella. The joint was closed. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

February 27: Death from pneumonia. Since the dressing was removed the animal has been using the operated knee-joint without apparent discomfort. *Autopsy*.—The joint was movable. The fascia was slightly thickened. It was adherent to the denuded end of the femur but to no other portion of the joint. Its structure was well preserved (Fig. 6).

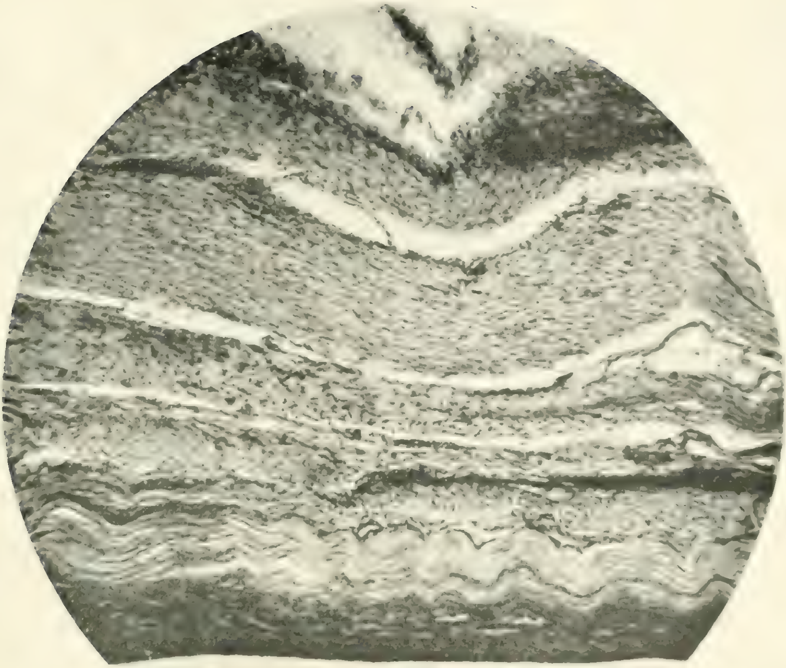
Histology.—Microscopic examination: the sections showed normal staining. well-nourished fascia. No signs of degeneration or absorption.

Experiment 31.—Male, yellow and white mongrel, about six months old. *Operation*, February 13, 1911: The right tibia was exposed and the periosteum stripped back. The bone was sawed through and then two strips of fascia lata were passed through drill holes and tied. The tied ends were made additionally secure by sutures. The wound was closed and a small drain inserted in the lower angle. Dry dressing, crinoline, and splint. Condition on leaving the table excellent. The stitches were removed on the fifth day. The wound was apparently nicely healed. It was practically impossible to immobilize the broken bone.

February 23: Distemper, animal sacrificed. *Autopsy*.—On removing the dressing the wound was found badly infected. In spite of the infection the strength of the fascia was apparently but little affected and the strips were still holding the ends of the bone together. This specimen was accidently lost.

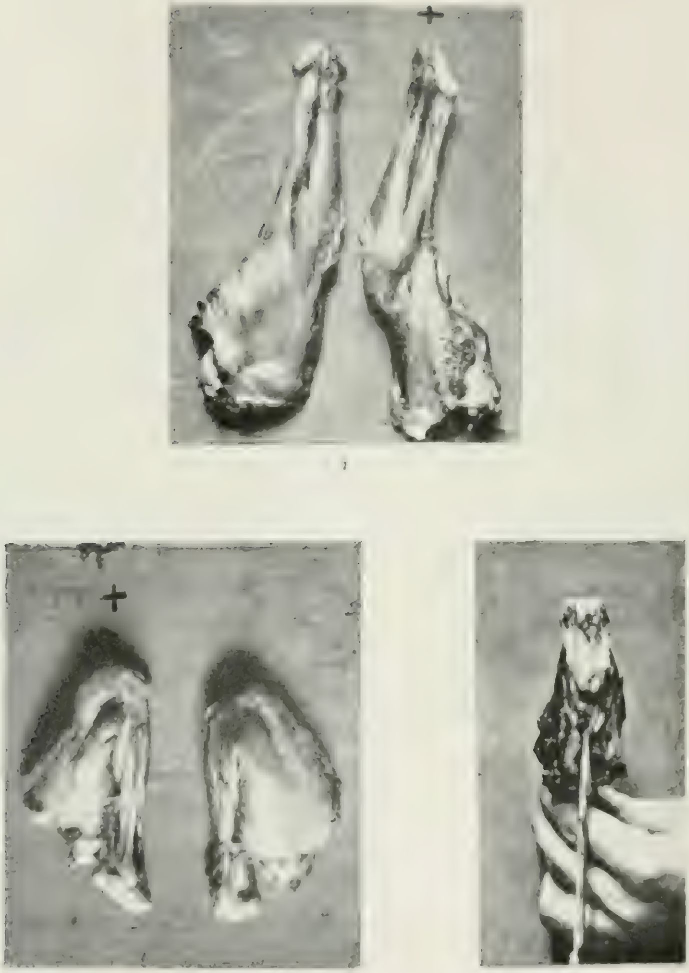
Comment.—This group is also interesting. Free flaps of fascia were successfully transplanted into joints and also to

Fig. 5.



(Microphotograph, Zeiss. Obj. AA. Oc. 3.) Two layers of [illegible] removal of patella. Section cut parallel to fascia bundles. Th[illegible] at the bottom of the plate is the portion toward the joint cavity.

Fig. 6.

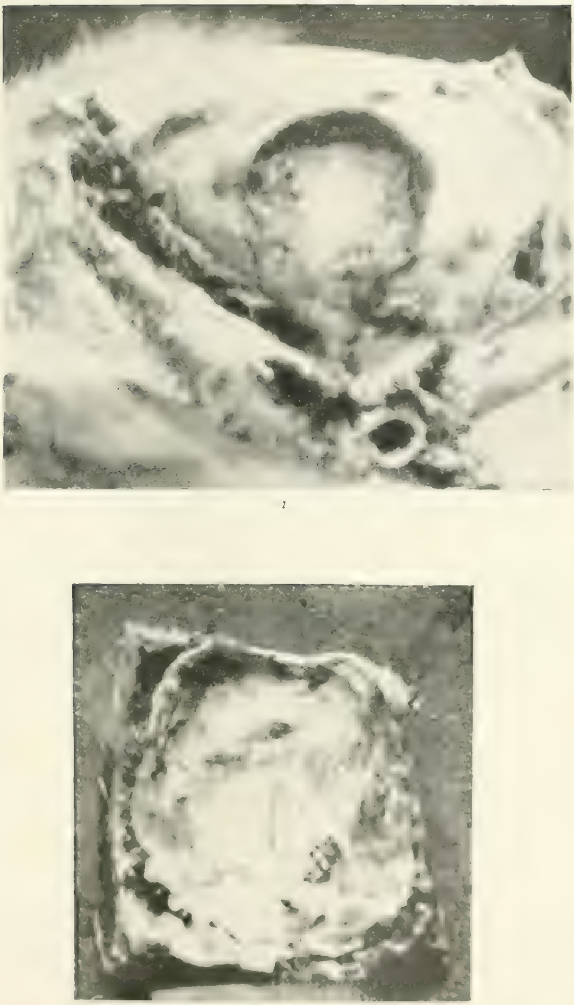

a

b

c

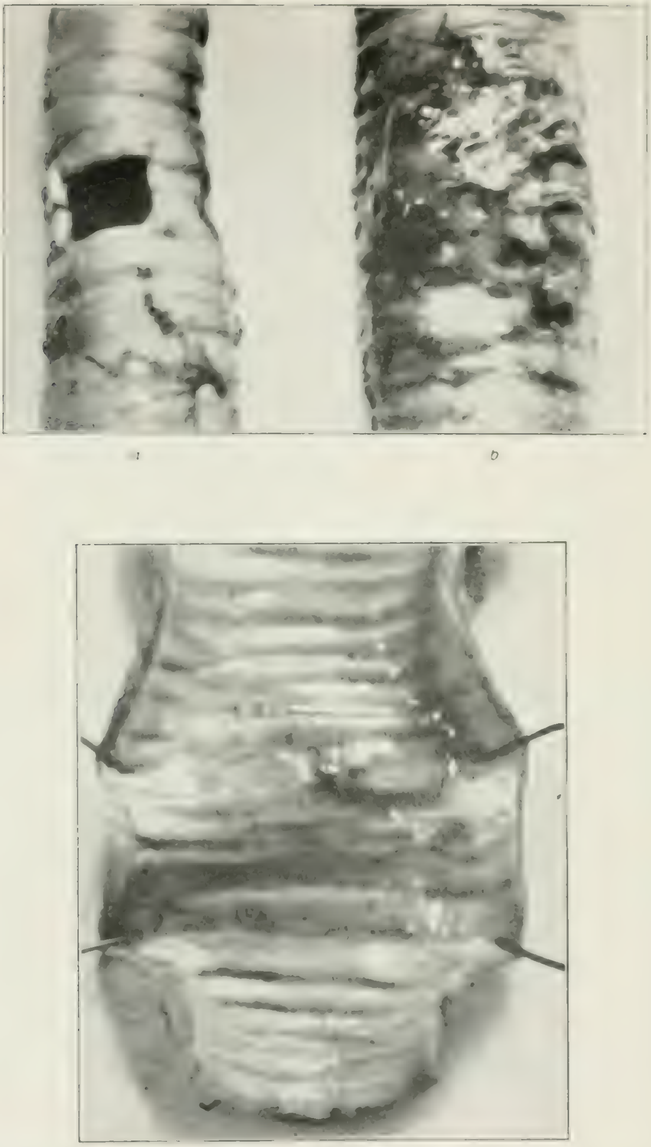
Experiment 29.—Fascia into joint after removal of the cartilage. Operation, February [illegible], 1911. Specimen removed February [illegible], 1911. (a) Leg extended compared with normal. (b) Leg flexed compared with normal. (c) [illegible] of joint. The + marks the operated limb.

FIG. 7.



Experiment [illegible].—Tumour into skull and dura, [illegible]. Operation, March 2, 1911. Specimen removed April 20, 1911. (a) Bone seen from outside with tumour adherent to bone edges. (b) Same, within the outline of the bone defect can be seen. The tumour is closely adherent to the dura which extends beyond it. The [illegible] almost normal but one small adhesion in the centre.

Fig. [illegible]



Experiment 62.—Fascia over defect in trachea. Operation, June 12, 1911. Specimen removed July 3, 1911. (a) Shows normal trachea with opening only the size of that covered by the fascia; (b) the fascia healed over a similar defect; (c) the same specimen from within, showing a slight depression which marks the defect. The mucous membrane has grown completely over the fascia.

take the place of patellæ which had been removed. Both of these procedures are suggestive clinically.

Bones were fractured and the fragments sutured with strips of fascia. The results of these last experiments were unsatisfactory on account of the difficulty in immobilizing the fragments. However, the use of fascia strips in the open treatment of fractures in human beings may be of great use clinically, as immobilization can be secured.

The fascia does not act as a foreign body, and has strength enough to stand any reasonable strain put upon it.

Group V.—Transplantation of Free Fascia into Defects in the Skull and Dura, also into Tracheal Defects.

EXPERIMENT 38.—Male, yellow mongrel, about one year old. *Operation*, March 6, 1911: The left temporal muscle with the underlying periosteum was turned back and a three-quarter inch button of bone was removed. The dura under this area was excised and a flap of fascia lata was tucked under the bone edges. The smooth muscle side of the fascia was placed next to the brain. The temporal muscle was replaced and sutured, and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

April 20: Distemper, animal sacrificed. *Autopsy.*—There was one small adhesion of the cortex to the central portion of the fascia. The edges of the fascia and dura were intimately blended. The structure of the fascia could be plainly seen. The fascia was tightly stretched across the bone defect and was firm and did not bulge on pressure (Fig. 7).

Histology.—Microscopic examination: the sections showed normal staining, apparently well-nourished fascia.

EXPERIMENT 62.—Female, black mongrel, about one year old. *Operation*, June 12, 1911: The trachea was exposed and an area 8 mm. square was excised. Over this defect was sutured securely a flap of fascia lata. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing. There was no cough or any respiratory symptom following the operation.

July 3: Animal sacrificed. *Autopsy.*—The fascia was somewhat thickened and firmly adherent to the surface of the trachea. There had been no leakage whatever. On opening the trachea from behind, the defect was made out as a very shallow depression and the fascia seemed to be entirely covered with mucous membrane, which had grown over it (Fig. 8).

Histology.—Microscopic examination: the sections showed the defect filled by normal staining, apparently well-nourished fascia. Over this fascia, as a base, the mucous membrane had grown, completely covering it (Fig. 9).

Comment.—This group shows that flaps of fascia inserted in skull defects between the dura and bone edges will heal and give a strong membrane which will resist considerable pressure from within and without. When the dura is removed in addition to the bone, the fascia flap tucked under the bone edges will unite with the dura and also become tightly adherent to the bone edges.

There was in each instance a single fine adhesion of the cortex to the centre of the fascia flap.

Fascia flaps might be used clinically in repairing skull defects and as an aid in closing of spina bifida.

This group also shows that free flaps of fascia may be successfully used to cover prepared defects in the trachea, without subsequent infection, and that the mucous membrane grows across the fascia covering the defect.

It might be of use, clinically, in closing old tracheotomy wounds, where there has been considerable destruction of cartilage, and also in reinforcing sutures of the trachea.

Group VI.—Transplantation of Free Fascia into Prepared Defects in the Abdominal Wall.

EXPERIMENT 17.—Male, white and black fox terrier, about one year old. *Operation*, December 22, 1910. All the tissues of the abdominal wall between the skin and the peritoneum were excised from an area about 4 by 7 cm. Into this defect a flap of fascia lata 3 by 6 cm. was sutured. The skin was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

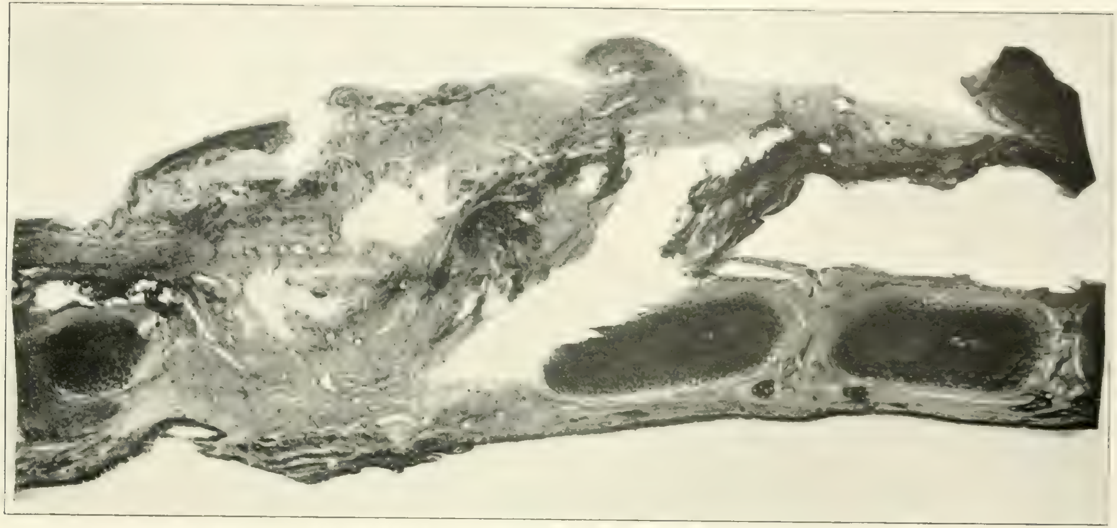
June 27, 1911: Animal sacrificed. *Autopsy.*—There was no hernia or bulging of the abdominal wall at the site of operation. From within there was no depression in the parietal peritoneum. On holding the specimen to the light the outline of the inserted fascia could be readily seen. The fascia itself was slightly thickened but normal in every way and was strong and tough.

Histology.—Microscopic examination: the sections showed normal staining fascia with no signs of degeneration.

EXPERIMENT 19.—Male, brown and black mongrel, about one year old. *Operation*, December 29, 1910: The peritoneum was exposed and an area 4 by 2 cm. was excised. Into this defect a piece of fascia lata was sutured. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

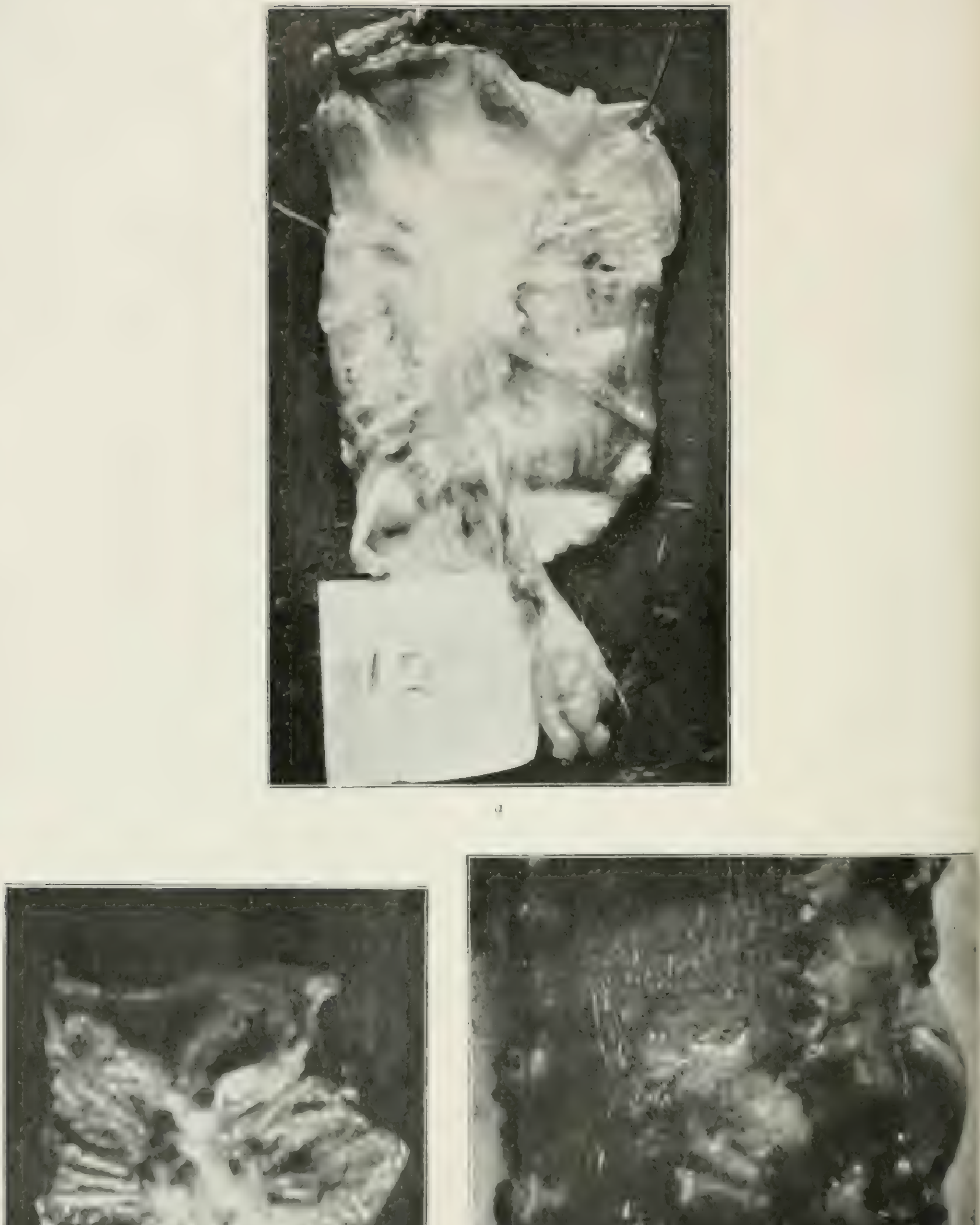
February 7, 1911: Animal sacrificed. *Autopsy.*—The fascia edges had blended with the peritoneum. It was thickened but otherwise seemed normal. There was a small omental adhesion.

Fig. 9.



(Microphotograph, Zeiss, Obj. AA, Oc. 3.) Longitudinal section of fascia covering a tracheal defect. The defect can be seen between the tracheal rings. On the right of the plate the fascia has become accidentally separated from the surface of the trachea during the preparation of the section. The mucous membrane can be seen covering the fascia.

FIG. 10.



Experiment 15.—(a) Fascia in peritoneal defect. Operation December 23, 1910. Specimen removed Febr 7, 1911. Experiment 23.—(b) Fascia on bladder. Operation January 10, 1911. Specimen removed June 27, 1911. Experiment 61.—(c) Fascia over defect in intestine. Operation, January 5, 1911. Specimen removed July 3, 1911.

In all of these the fascia was thickened. It was incorporated with the peritoneum and there was a puckering the peritoneum at the margin of the fascia. There was adherent omentum in each case. A small tag can be seen in a

Histology.—Microscopic examination: the sections showed normal well-nourished fascia.

Experiment 46.—Male, yellow and white mongrel, about one year old. *Operation,* March 23, 1911: A section of the abdominal wall 3 by 7 cm., including everything except the skin, was excised. Into the peritoneal defect was sutured a flap of fascia lata from one thigh, and into the muscle defect, a flap from the other thigh. The skin was closed in the usual manner. Dry dressing. Condition on leaving the table excellent.

The animal developed distemper three days after the operation and on the fifth day the skin wound broke down. There was no hernia, as the fascia held firmly.

April 6: Death from distemper. *Autopsy.*—There was a crater-like ulcer, whose base was made up of fascia on which granulations could be seen both at the edges and scattered over the surface. There was no hernia whatever, and the fascia seemed to be strong and intact. On opening the abdominal cavity there was free pus, and this was also found in the pleural cavity. The omentum was adherent over a small part of the fascia. The fascia was incorporated with the peritoneum and had healed firmly in position.

Histology.—Microscopic examination: the sections showed infiltration with leucocytes, and marked signs of infection. The fascia was apparently in good condition with clearly stained fibres and nuclei. There was definite granulation tissue growing from the ulcer edges out on the fascia.

Comment.—This group shows that free flaps of fascia may be sutured into peritoneal and muscle-fascia defects in the abdominal wall, and that it will incorporate itself with the surrounding peritoneum and muscle edges. A small omental adhesion was present on examination of the specimen in each instance, but in no case was there adhesion of the gut or any other abdominal organ to the fascia.

When a hernia was produced by the removal of a portion of the abdominal wall, except the skin, it was readily cured several weeks later by the transplantation of fascia flaps.

These experiments suggest the use of fascia flaps in the cure of large herniæ, where the muscle is atrophied, and for strengthening any weakened area in the abdominal or chest wall. The facility with which the fascia unites with the peritoneum suggests its further use in pleural and pericardial defects.

Group VII.—Transplantation of Free Fascia onto Stomach, Intestine, and Bladder.

Experiment 23.—Female, brown and black mongrel, about one year old. *Operation*, January 10, 1911: The bladder was brought up through a midline incision, and a flap of fascia lata was sewed to it with a continuous suture. The bladder was dropped back and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

June 27: Animal sacrificed. *Autopsy*.—There were omental adhesions to the fascia. The peritoneum on the surface of the bladder was somewhat puckered under and immediately around the fascia edges. The fascia itself was thickened, but otherwise seemed normal.

Histology.—Microscopic examination: normal staining fascia was found. The peritoneal covering of the bladder could not be differentiated.

Experiment 24.—Female, yellow mongrel, about six months old. *Operation*, January 16, 1911: The stomach was exposed and an incision 3.5 cm. long was made in it, down through the mucosa. The incision was then closed with the Cushing continuous stitch, and over the suture line was placed and sutured a flap of fascia lata. The stomach was dropped back and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

January 27: Distemper, animal sacrificed. *Autopsy*.—The fascia was thickened but otherwise seemed normal. It was closely adherent to the stomach wall. There were a few omental adhesions to the fascia, but these could be easily separated.

Histology.—Microscopic examination: the sections showed the line of suture. Above this was the layer of fascia which was apparently normal and well nourished.

Experiment 61.—Male, black and white fox terrier, about one year old. *Operation*, June 5, 1911: A loop of gut was brought up through an abdominal incision and a purse-string suture was placed opposite the mesentery. When the suture was drawn tight and tied the portion within the suture projected outward. The tip of the projection was cut off, exposing the lumen of the bowel. Over this area a flap of fascia lata was sutured snugly and the gut was dropped back. The wound was closed in the usual manner. Dry dressing. *Per primam* healing.

July 3: Animal sacrificed. *Autopsy*.—The omentum was adherent to the fascia, but this was easily separated. The fascia was somewhat thickened, but otherwise seemed normal. It was closely adherent and seemed incorporated with the peritoneum of the bowel. There was a definite puckering of the wall of the gut around and under the fascia. There had been no leakage. From within a small depression in the mucous membrane could be seen corresponding to the pucker made by the purse-string.

Histology.—Microscopic examination: the sections showed normal staining, well-nourished fascia. There was marked infiltration of the tissue beneath the fascia with polynuclear leucocytes. There was a great mass of these cells in the area corresponding to the made defect. On the surface of the fascia was the remains of the adherent omentum..

Comment.—This group of free fascia flaps were successfully transplanted onto the stomach, the intestine, and the bladder. The fascia seemed to incorporate itself with the peritoneum (Fig. 10).

Clinically fascia might be used to strengthen suture lines and weakened areas due to ulceration. It might also be of use in closing fistulæ of one sort or another.

Group VIII.—Transplantation of Free Fascia on Liver, Kidney, and Spleen.

Experiment 36.—Female, brindle mongrel, about eighteen months old. *Operation*, February 21, 1911: Through a lumbar incision the left kidney was exposed and after the capsule was stripped back an abrasion of the surface was made and a flap of fascia lata was sutured over it. The hemorrhage ceased promptly. The kidney was dropped back and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

March 7: Distemper, animal sacrificed. *Autopsy.*—The skin wound which had apparently healed became infected after the development of the distemper. The fascia was adherent to the surrounding tissues. It was not much thickened and seemed normal. It was tightly adherent to the kidney at the edges, but could be stripped up more easily in the centre of the flap.

Histology.—Microscopic examination: the sections showed normal fascia closely adherent to the parenchyma.

Experiment 52.—Male, black mongrel, about three months old. *Operation*, May 8, 1911: Through a high midline incision a lobe of the liver was exposed. The end of the lobe was cut off with scissors, leaving a bleeding area 3 cm. × 0.6 cm. Over this surface was placed a flap of fascia lata and the bleeding was markedly checked. The fascia covered the end like a shallow cap, and was held in position by mattress sutures passing through the liver substance and through both sides of the fascia. These sutures were drawn as tight as desired, and did not cut through the liver substance. The liver was dropped back and the wound was closed in the usual manner. Condition on leaving the table excellent. *Per primam* healing.

June 6: Death from pneumonia. *Autopsy.*—There was adhesion of the omentum to the fascia. When this was stripped off the fascia was seen covering the denuded area like a cap. It was slightly thickened but otherwise seemed normal.

Histology.—Microscopic examination: the sections showed normal staining, well nourished fascia surrounding an area of liver substance. It was adherent to a considerable extent.

Experiment 60.—Black and white fox terrier, about one year old.

Operation, June 5, 1911: The spleen was brought up through a left rectus incision, the edge was trimmed with scissors, and a flap of fascia was sutured over the denuded area so as to bind it. The fascia was held with mattress sutures, which passed through the spleen and both edges of the fascia. There was considerable hemorrhage until the fascia was applied and the sutures tied. The spleen was dropped back and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

July 3: Animal sacrificed. *Autopsy.*—The fascia was thickened and securely bound the edge of the spleen. It seemed well nourished, and it could be separated from the spleen quite easily.

Histology.—Microscopic examination: sections showed normal staining fascia surrounding spleen tissue.

Comment.—In this group free flaps of fascia were successfully transplanted on the liver, kidney, and spleen. It suggests that the fascia flaps might be used to support sutures in these organs, and also to bind raw post-operative surfaces (Fig. 11).

It is to be noted that the fascia when applied to a bleeding surface seemed to have a definite hæmostatic effect, which is comparable to the hæmostatic action of bits of muscle, spoken of by Cushing.

The kidney might be suspended to the ribs or muscles in a sling of free fascia. These results are very promising.

Remarks.—In none of the animals have I noted a muscle hernia after the fascia was removed, but should it occur the hernia could be repaired without difficulty. There is apparently no untoward effect after removal of the fascia lata as far as the use of the limb is concerned.

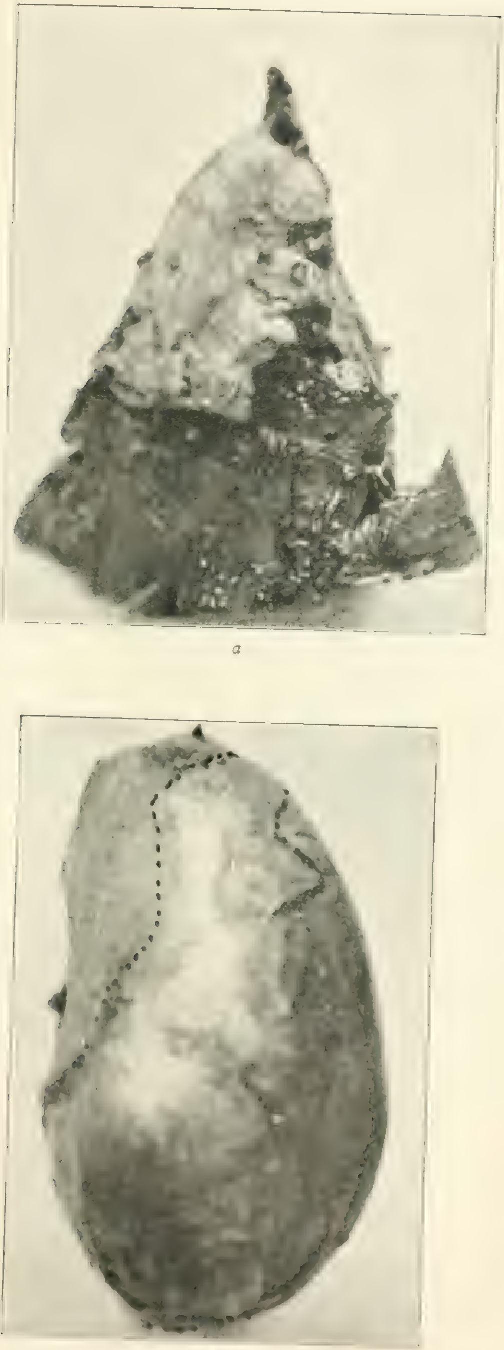
In every instance the fascia retained its own structure and seemed well nourished. After removal from its bed it was as tough and strong as when first transplanted.

The great strength of the fascia, and, in addition, its thinness and flexibility are to be noted. It can be sutured into a defect under considerable tension, and the sutures will hold securely even when inserted close to the edges or ends of the flap.

The great supply of this material and the ease with which it can be obtained are important points.

There is some difference in the measurements of flaps of

Fig. 11



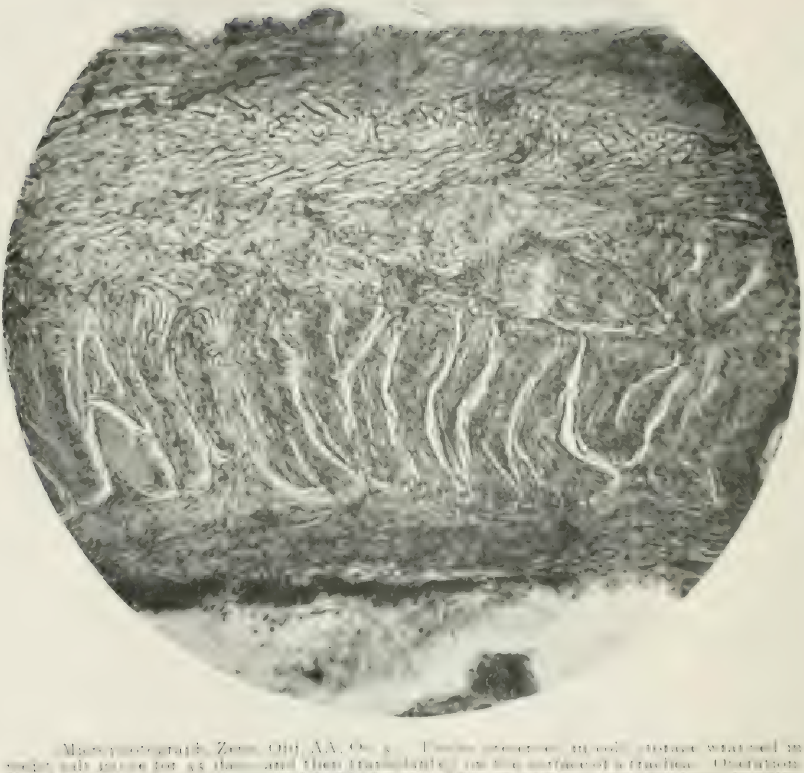
a

b

Experiment 25.—(a) Fixation of [illegible] lobe of the liver. Operation January [illegible]. Specimen removed January [illegible] 1911. The capsule was thickened but was adherent to the liver surface over most of its extent. Experiment 26.—(b) Fixation of kidney. Operation February [illegible] 1911. Specimen removed March [illegible] 1911. The fascia is closely adherent to the kidney substance and blends with the capsule.

In both of these specimens, as in all the others, the fascia was not [illegible].

FIG. 12.



Microphotograph. Zeiss Obj. AA. Oc. 4. Fascia preserved in cold storage wrapped in moist salt gauze for 45 days and then transplanted on the surface of a trachea. Operation March 19, 1910. Specimen removed April [illegible], 1911. The section is across the [illegible]. The fascia is normal in appearance and stains well.

fascia before and after removal. For example, a marked out flap of fascia lata measured 4.5 x 2.5 cm. before removal, and after removal it measured 3.3 x 2 cm. Another flap measured before removal 4.5 x 2.2 cm. and after removal 4 x 1.75 cm.

In several experiments fascia was drawn taut and sutured around firm rubber tubes 0.8 to 1 cm. in diameter, and then inserted in the subcutaneous tissue. These specimens were removed after 49 to 54 days. The structure of the fascia could easily be seen. Microscopic examination showed normal staining fascia with no signs of degeneration.

This is interesting, as it shows that fascia will receive sufficient nourishment if only one surface is exposed to living tissues.

The type of so-called distemper prevalent in the laboratory this winter appeared to have some effect on the healing of the wounds, and a number of them became infected. This did not seem due to a break in technic, as other animals operated on the same morning (before and after these animals), with identical technic, and not developing the distemper, did not break down.

In several animals whose stitches had been removed after *per primam* healing, the skin wound subsequently broke down after the development of distemper.

In the instances where there was infection, the transplanted fascia seemed particularly resistant to it, and retained its structure after breakdown of the surrounding tissues.

Where there was tension on the fascia there was comparatively little thickening, but wherever the fascia was simply laid on a tissue there was always thickening, and unless it was held flat with sutures it had a tendency to bunch or roll up.

Once or twice the fascia flap was accidentally allowed to partially dry out before it was transplanted, but in spite of this it was moistened with salt solution and transplanted. The results were excellent and the fascia was nourished and grew in its new position.

The question naturally arose as to the necessity of transplanting the fascia immediately, and also whether fascia from one animal could be successfully transplanted into another.

Experimentally, both of these questions have been answered satisfactorily (Fig. 12).

Fascia was successfully transplanted into the same and other animals after being kept in an ordinary ice chest, 38° for as long as 7 days; in cold storage 32° wrapped in gauze moistened with salt solution for 35 days, and in cold storage 32° in normal salt solution for 56 days.

I am sure that the number of days given here do not show the greatest time that fascia may be preserved by the methods spoken of, but I mention the periods as a suggestion that suitable fascia might be preserved until needed for clinical use.

Fascia kept in salt solution appeared œdematous when first removed from the solution, but the œdema disappeared when the tissue was pressed with dry gauze. The œdema was entirely in the superficial connective tissue, which had not been removed. The fascia kept in moist salt gauze, on the other hand, was normal in appearance.

When fascia was sutured to the surface of the stomach, intestine, or bladder, within a few days there was the appearance of puckering or drawing up of the surface under the fascia and at its edges, somewhat similar to the effect of ordinary collodion on the skin. On this area, from within the organ, this puckering was not to be found and the lumen was in no way encroached upon.

The hæmostatic action of free fascia flaps is noteworthy.

CONCLUSIONS.—The foregoing experiments give an idea of the great possibilities of transplanting free flaps of fascia, and many suggestions for the clinical use of this substance may be drawn from them.

I feel convinced that many of the difficult situations arising during operations for the repair of weakened and defective tissues or for the control of bleeding surfaces will be simplified by the use of free fascia flaps and shall report the results of its use in such cases with a consideration of the literature in a subsequent paper.

EXPERIENCES IN THORACIC SURGERY UNDER ANÆSTHESIA BY THE INTRATRACHEAL INSUFFLATION OF AIR AND ETHER.*

WITH REMARKS ON THE VALUE OF THE METHOD FOR GENERAL ANÆSTHESIA.

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About two years ago, Meltzer and Auer first described the method of artificial respiration by the intratracheal insufflation of air. In later publications they showed that in animals the method was of great value for experimental investigations in which one or both pleural cavities had to be opened. They described a very simple method by which the animals could be anæsthetized by intratracheal insufflation of air and ether, and expressed their belief that the method would be of great value for thoracic surgery in the human being. Soon afterward, Carrel made use of the method for his operations upon the heart and aorta of dogs, and recommended it for intrathoracic experimental work. At the same time, the writer had been making a large number of investigations on dogs, and with the aid of Dr. Neuhof had performed a not inconsiderable number of operations upon the lungs, the bronchi, and the œsophagus in these animals. Thus we removed one or several lobes of one or both lungs, made incisions into bronchi, with subsequent suture, etc. In all of these operations the method of intratracheal insufflation worked admirably. One or both pleural cavities could be widely opened, and all the necessary intrathoracic manipulations performed and the animals remain in good condition throughout the operations. After the thoracic wall had been closed by suture and the intratracheal insufflation stopped and the intratracheal tube removed, the animals began to breathe again in a perfectly normal manner. Unless death occurred from sepsis or followed from an unsuccessful operative procedure, the animals recovered entirely. When the dogs were killed days, weeks, or months after the operations, the larynx, trachea, and lungs were found in perfectly normal condition.

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*Read before the Philadelphia Academy of Surgery, May 3, 1911.

As has been described in previous papers, the insufflation was carried on by means of a very simple apparatus which had been devised by Meltzer and Auer, and no care was taken to filter, warm, or moisten the air which was blown into the trachea. Nevertheless no lesion could be found post mortem in the respiratory tract of these dogs. The anæsthesia was a very good one and seemed to be absolutely devoid of danger. It is well known that it is easy to kill a dog by means of ether given by inhalation, but we have found it impossible to kill the animals with ether given by intratracheal insufflation. This safety is probably due to the fact that so much of the ether escapes upward in the trachea and out through the larynx and mouth.

In previous papers, I have described a simple and portable apparatus for intratracheal insufflation anæsthesia in man. In what follows I shall give an account of our experiences with the method for general anæsthesia and shall report upon the cases of intrathoracic surgery which we have had up to the present time.

The Value of Insufflation Anæsthesia for General Surgery.—We have, at Mt. Sinai Hospital, New York, anæsthetized about 200 patients by means of intratracheal insufflation, and have found the method very valuable for a great many operations. In all but a few cases, the anæsthesia was a very satisfactory one, particularly free from complications and after effects. It is very easy to keep the patients under full anæsthesia, vomiting has never occurred during the anæsthesia, and the patients were never too deeply under the ether. At the conclusion of the operations, the patients awakened very rapidly, especially if pure air was insufflated for a few minutes before the intratracheal catheter was withdrawn. Vomiting after the operation was very unusual no matter what the surgical procedure that had been performed, and the patients never complained of pain or discomfort in their laryngeal regions. We have thus far not seen any pulmonary complications after insufflation anæsthesia.

In one patient, we failed to obtain complete muscular relaxation so that the necessary intra-abdominal manipulations could be accomplished.

In the case of a young girl, who was to be operated upon for chronic appendicitis, it was found impossible to cause complete relaxation of the abdominal walls. We finally attempted to obtain complete anæsthesia by means of ether given by inhalation, but the patient still struggled. Only when chloroform was given by inhalation was perfect relaxation obtained.

This patient was evidently one who was refractory to ether. It is possible that the intratracheal tube that we used was too small, so that too much of the air and ether mixture escaped by the side of the tube.

Operations under insufflation anæsthesia were performed upon patients suffering from a variety of acute and chronic surgical diseases. Our experience up to the present time will allow us to mention the following operations in which we have found the anæsthesia of especial value. In operations upon the neck and more especially those around the trachea such as thyroidectomy, the method is very useful. Not only is the anæsthetizer never near the field of operation, but the operator can work around the trachea without causing any interference with the breathing. There is no danger of sudden collapse of the trachea when a large goitre has been removed, and no matter how much the trachea is handled, the anæsthesia continues smoothly and evenly. Intratracheal anæsthesia should be very advantageous for the operation of laryngectomy. The intratracheal tube could either be introduced through a tracheotomy wound and the trachea packed with gauze above this point, or the tube could be passed through the glottis in the usual manner, and removed only at the moment when the trachea is to be divided across after the entire larynx is free.

We have found that operations upon the face and jaws and mouth, where the buccal cavity or pharynx has to be in vaded, are made more easy and safe when done under insufflation anæsthesia. No blood or secretions can run down the trachea, for the out-flowing current passing upward in the trachea blows out any fluid that might run down into the larynx.

In operations upon the brain and spinal cord where the patient must often be placed in the prone position, the anæsthesia is very useful. As soon as the intratracheal tube has been introduced and the insufflation has been begun, the patient's head and body can be placed in any position desired and the anæsthesia given from a distance. The anæsthetizer need not be seated underneath the table as is ordinarily necessary.

Experiences with Insufflation Anæsthesia in Thoracic Surgery.—Insufflation anæsthesia is a positive pressure method and was primarily suggested for intrathoracic surgery. On account of the simplicity and apparent safety of the method it may take the place of all the more complicated positive and negative pressure cabinets. The operations upon animals gave such very satisfactory results, that we were very hopeful that the method would give as good results in thoracic operations in the human being. We were very careful in our first human operations, but, with increasing experience, have gained more and more confidence in the efficiency of insufflation in man. In the following are recorded the experiences we have had up to the present time:

CASE I (Reported in the ANNALS OF SURGERY, July, 1910).—*Abscess of the lung; thoracotomy and aspiration of the lung under intratracheal insufflation. Recovery.*

B. F., a butcher, fifty-five years of age, was referred to the II Surgical Service by Dr. Manges with the diagnosis of an abscess of the middle lobe of the right lung.

February 14: The patient was anæsthetized with ether, and the attempt was made to introduce a small catheter into the trachea. The patient took the ether very badly, and I did not have on hand the proper kind of a tube nor the necessary instruments for the intubation. After a number of unsuccessful attempts to pass a catheter through the larynx we determined to put off the intubation until a later time. The operator (Dr. Lilienthal) then resected four inches of the eighth and ninth ribs and packed the wound cavity with gauze.

February 20: Operation by Dr. Lilienthal, intratracheal insufflation by Dr. Elsberg. Ether anæsthesia; larynx and pharynx thoroughly anæsthetized with cocaine. A soft rubber tube, No. 28 French scale, was passed through the glottis by means of a laryngeal forceps and pushed downward until a slight resistance was encountered. The tube was then fixed to the upper teeth by means of a gag. The tube was connected with the insufflation apparatus and a mixture of air and ether blown in under a pressure of 15 mm. of mercury. The patient began to cough violently, therefore the intratracheal tube was withdrawn about one inch. The coughing ceased at once, and at the same time all evidences of mucus in the trachea or pharynx disappeared. The patient's color was good, respirations regular, pulse of good quality. The patient was now turned on the left side and the operation begun.

3.10—No cyanosis, pulse 120; incision 12 cm. in length into right pleural cavity; pulse unchanged, color good, no cough. Pressure of current now raised to 20 mm. Palpation of the lobes of the right lung.

3.20—Pulse 108; respirations 48; color good with slight cyanosis; pleural cavity is wide open.

3.25—Heart action excellent; pulse 96; color good, no cyanosis; aspiration of middle lobe of lung.

3.30—Pulse 105; respirations 42; color good.

3.35—Pulse 108; respirations regular, 40. The current of air is interrupted several times in order to observe the appearance of the lung. When the current is prevented from entering the intratracheal tube the lung collapses and is of a dark green mottled color; when the lung is markedly distended (25 mm. pressure) the lung is of a bluish color with areas of red. When the lung is collapsed the œsophagus and aorta can be seen and examined.

3.40—Suture of incision in pleura. While the last stitches are being passed the pressure is raised to 30 millimetres in order to slightly overdistend the lung so that as little air as possible shall remain in the pleural cavity.

3.45—Pleura closed with small drain; pulse 132 and of good quality.

3.50—Color good, no cyanosis; respirations 32.

3.55—Suture of muscles and skin; voluminous dressing. The intratracheal tube is withdrawn. Pulse now 120, of good quality; respirations regular, no cyanosis.

Four minutes after the patient was taken to his bed he was awake. He said that he did not have any pain in his larynx; he was not hoarse. The morning after the operation the patient was in very good condition. He complained of some pain in the right chest and had considerable mucopurulent expectoration. He was not hoarse and did not complain of any pain in his laryngeal region. The auscultation of the right side of the chest through the bandages was not satisfactory, but breathing sounds could be heard over the entire side.

From this time on the patient steadily improved, the cough and expectoration grew less daily; he was out of bed on March 10 and was discharged from the hospital with his wound almost healed on March 25. When last seen (April 22) he was in excellent condition; the breathing sounds over the right side of the chest seemed normal; he had almost no cough and practically no expectoration; he had gained considerable flesh and strength.

The patient returned to the hospital about six months later on account of a large pulmonary hemorrhage. He had another large hemorrhage from the lungs soon after his admission, to which he succumbed. No autopsy could be done.

Case II.—John H., fifty-two years of age, admitted to Mt. Sinai Hospital on January 2, 1911, with the history of increasing difficulty in swallowing for ten months. He had lost 40 pounds in weight and was able to swallow only small quantities of fluids. The stomach tube was arrested 12 cm. from the teeth, and an X-ray picture taken after the ingestion of bismuth showed a marked narrowing of the œsophagus at this point.

On January 7 the patient was anæsthetized with ether in the usual manner, a catheter No. 24 French introduced into the trachea, and intratracheal insufflation begun. The patient was turned on the right side, and an incision was made in the seventh intercostal space from the costal cartilage in front to the angle of the ribs behind (Dr. Elsberg). The incision was deepened through the muscles until the pleura was exposed. The lungs were now momentarily collapsed while the incision in the pleura was made. The ribs were now drawn apart by means of the rib spreader and the left pleural cavity widely exposed. The lungs were of a mottled pink color and moderately distended (pressure 30 mm.). Pulse slow and of good quality; very superficial respiratory movements. The lung was now carefully drawn toward the median line and the pericardium exposed; this was also drawn to the right so that the root of the lung was visible as well as the aorta and the œsophagus with the left vagus nerve.

About five inches above the diaphragm there was a hard nodular tumor of the œsophagus of the size of a large plum. There were no enlarged glands at the root of the lung. The tumor was free on all sides excepting where it lay against the aorta. The attempt was made to free it from its attachments to the aorta, but this was found impossible without great danger to the wall of the vessel. The tumor was, therefore, considered inoperable.

The incision in the pleura was closed by a fine running catgut suture, with interrupted sutures of strong catgut around the adjoining ribs. When the last stitches in the pleura were being passed, the anæsthetizer was instructed to raise the pressure to 50 mm. of mercury, so as to distend the lung and expel as much air as possible from the pleural cavity. Then followed suture of the intercostal and pectoral muscles and skin in the usual manner. Large vaseline gauze dressing.

During the entire operation, which had lasted 57 minutes, the patient was in good condition; color of face pink, breathing superficial, pulse of good quality. Insufflation of pure air for three minutes at end of operation; then removal of intratracheal catheter.

Five minutes later the patient was awake and responded to questions. Four hours after the operation the respirations were 24 to the minute, and upon auscultation through the dressings, breathing sounds could be heard all over the left chest.

Convalescence thereafter was smooth and uncomplicated; the patient never had any respiratory difficulty; his pulse and respirations were practically normal; he was sitting up in bed on the third day after the operation.

On the evening of the sixth day after the operation, his temperature suddenly rose to 102°, and he suddenly complained of severe pain in the left chest, his pulse became very rapid and feeble. In spite of active stimulation he soon went into a condition of collapse and died a few hours later.

The post-mortem examination showed that there had occurred an infection of the pleural cavity by direct extension from the ulcerated carcinoma of the œsophagus.

Remarks.—From the stand-point of the insufflation, the operation was highly successful, and all the manipulations within the chest were accomplished with perfect ease. The lungs were distended and collapsed at will, and all parts of the pleural cavity could be well exposed. At no time was the operator disturbed by violent movements of the lung; the slight respiratory movements which the patient made were not at all communicated to the lung, which remained practically immobile. The fatal outcome was probably due to an infection from the ulcerated tumor, although an operative infection may have occurred.

CASE III.—*Abscess of the lung in a man of twenty-four years. Chronic abscess of the middle lobe of the right lung*

Marked cyanosis during the preliminary ether anæsthesia by inhalation. Color became good as soon as the insufflation anæsthesia was begun; pulse good during the entire operation. Thoracotomy; incision of the lung; drainage of an abscess cavity in the middle lobe of the right lung (Dr. E.). Uncomplicated convalescence with persistence of bronchial fistula. Death after several months from a metastatic abscess of the brain.

CASE IV.—Female. *Bronchiectatic abscess of the right lower lobe.* Thoracotomy and exploration of the lung (Dr. E.) under insufflation anæsthesia (pressure 25 to 35 mm.). Condition of patient good during entire operation. The abscess cavity had emptied itself before the operation and could not be found.

CASE V.—Female. *Metastatic abscess of the lung after an infarct following another operation.* Intratracheal insufflation, thoracotomy and drainage of abscesses in left upper and lower lobes (Dr. E.). Condition of patient during operation good. Breathing movements ceased as soon as pressure is raised to 40 mm. of mercury. Recovery from the operation rapid and uncomplicated, but fever persisted. Patient died about six weeks after the operation. The autopsy showed that there were numerous abscesses that had not been drained.

CASE VI.—Female. *Interlobar empyema.* Thoracotomy and drainage under insufflation anæsthesia (Dr. Gerster[1]). Recovery.

CASE VII.—Female. *Gangrene of the lung.* Intratracheal insufflation anæsthesia. Marked cyanosis during preliminary anæsthesia; insufflation of air, oxygen, and ether. Color pink after insufflation was begun. Thoracotomy and drainage of gangrenous areas in right lung (Dr. Gerster[1]). Insufflation anæsthesia very satisfactory; satisfactory recovery from the operation itself. Death about one week after the operation from exhaustion from the sepsis.

CASE VIII.—Male. *Interlobar empyema.* Intratracheal insufflation. Thoracotomy and drainage (Dr. E.). Insufflation anæsthesia very efficient; lungs could be distended and collapsed at will. General condition of patient remained good during the entire operation. Uncomplicated recovery.

CASE IX.—Female, operated upon in Worcester, Mass. *Recurrent carcinoma of chest-wall* after extirpation of breast for carcinoma seven years before. Insufflation anæsthesia; catheter

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[1] I am indebted to Dr. A. G. Gerster for permission to include his two cases.

No. 24 F. used; pressure 25 mm. of mercury. Radical extirpation of affected area of right chest-wall with parts of two ribs and of the sternum. Large opening in right pleural cavity. When pleura was opened, lungs were found moderately distended and immobile. Opening in pleura closed by continuous suture of fine catgut; while last stitch was passed pressure raised to 40 mm. so as to expel as much air as possible from the pleura. Suture line of pleura covered by a muscle flap from the serratus. Suture of skin with the aid of plastic flaps; large vaseline dressing. Anæsthesia and operation uncomplicated; pulse 90 to 100 during operation; slight respiratory movements during entire insufflation. Patient awake before she had been removed from the operating table. Convalescence thus far uneventful.

In all of the thoracic operations above reported, as well as in a large number of thoracotomies for empyema that we have done, the anæsthesia was a very good one. In not a single instance were any changes in the patient's condition observed when the pleural cavity was first opened; the pulse remained regular and of good quality and the patient's color remained good. In several of the cases, there were adhesions between the visceral and parietal pleuræ, but in most of the patients whose histories are given above, there were no adhesions, and the practically normal pleural cavity was invaded. We have not yet had occasion to operate upon a patient in whom both pleural cavities have to be opened. Such a case would be the supreme test of intratracheal insufflation. There is, however, every justification for the belief—based upon the results of animal experiments in which both pleural cavities were widely opened, and upon the experiences we have had with insufflation as a method of artificial respiration in several patients in whom all respiratory movements had been abolished—that it will be safe to open both pleural cavities if necessary, as far as the dangers from the double pneumothorax are concerned. The cases here reported are too few to allow one to draw final conclusions, but they do indicate that in the method of intratracheal insufflation we have at last a simple method for the avoidance of those dangers which have prevented the development of surgery of the intrathoracic viscera.

STUDIES ON PERITONEAL ADHESIONS.

WITH A CONTRIBUTION TO THE TREATMENT OF DENUDED BOWEL SURFACES.

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THE problem of peritoneal adhesions is one that merits the serious consideration of everyone engaged in abdominal surgery. That this fact is generally recognized is indicated by the large number of valuable contributions to the subject—including not only elaborate experimental researches of the most diversified sort, but also carefully recorded clinical observations—contained in the literature of the past twenty-five years. The results of all this work have been both gratifying and disappointing; gratifying in so far as certain valuable procedures have been both scientifically and empirically established, but disappointing in that the work is still unfinished, and is, indeed, in a state of confusion as regards the actual worth of numerous procedures very commonly employed and from time to time enthusiastically advocated; often it appears, without adequate scientific justification.

It is the purpose of this communication to present a collective and analytical review of this voluminous literature, classified along practical, common-sense lines, to impartially weigh the evidence, and to draw such conclusions as seem warranted. In connection with this critical study I shall describe a new and original method of dealing with denuded bowel surfaces.

Much of the existing confusion could have been avoided, it seems to me, if investigators had kept in mind the fact that peritoneal adhesions, like bacteria, are of two kinds—those which are useful and of essential worth to mankind, and those which are harmful and inimical to life or health. They represent in every instance nature's best method of defense or of repair. Moreover, as we shall see later on when we come to consider the pathological processes involved in their formation, it is highly probable that they will always remain a necessary part of abdominal surgery, and that we can never hope to discover a prophylactic or curative agent that will prove to be a panacea for all cases. Indeed, it seems to me that efforts along this line are fundamentally wrong, and that they represent misdirected energy. For whenever and however the peritoneum is injured it must be repaired, if the individual is to survive. But the very processes involved in this repair include, in many instances, the necessity of adhesion formation. The search after some specific and potent remedy for this, therefore, represents no less ambitious an undertaking than to provide nature with a substitute method of repair in the peritoneal cavity that possesses improvements over her own! Now it is very obvious that this is impossible, and that the abdominal surgeon must accept the inevitable, and equip him self to reckon intelligently with peritoneal adhesions as a vexing but necessary part of his work. It will be found in the last analysis that he has recourse to three classes of procedure: (1) measures which prevent adhesions; (2) measures which restrict their formation to the harmless variety; and (3) measures which aid in their absorption.

Before discussing systematically the various procedures belonging to each of these classes, let us recall briefly several characteristics of the peritoneum itself which have an important bearing upon this problem.

First of all, we are apt to forget the enormous area of this serous membrane which has been estimated to be only slightly less than that of the skin. Again its remarkable absorptive power is so striking that it has actuated a number of investigators to undertake elaborate and laborious researches to determine its mechanism. It is conceded by all that the lymphatic absorption is most active in the upper part of the abdomen, especially on the under surface of the diaphragm and in the omentum, while in the pelvis it is relatively sluggish —a fact now commonly taken advantage of by surgeons in the use of the Fowler or sitting posture in the treatment of peritoneal infections. Furthermore, it is generally admitted that solid particles—such as coloring matter in suspension, bacteria, oil globules, etc.—are taken up by the lymphatics. But concerning the process of absorption of fluids and soluble substances, there is some difference of opinion as to whether it occurs through the blood-vessels or the lymphatics. Starling and Tubby[1] introduced into the peritoneal cavities of dogs salt solution colored with indigocarmin, and methylene blue, and noted the time of its appearance respectively in the thoracic duct and in the urine. They found that it appeared much earlier in the urine, from which they concluded that the absorption had been through the blood-vessels. Mendel[2] later confirmed these observations, using the same methods. Hamburger[3] studied the effect of ligating the left innominate vein —*i.e.*, practically the thoracic duct— upon absorption of fluids of different osmotic pressures introduced into the peritoneal cavities of rabbits, and concluded that the lymphatics play a very small part in the process of absorption. Orlow[4] concluded that the blood capillaries are the essential paths of fluid absorption. By introducing a measured quantity of fluid into the abdominal cavities of dogs and withdrawing the remainder after a few hours, he observed invariably that a large amount had been absorbed, while the flow of lymph through the thoracic duct, measured before introducing the fluid and after its withdrawal, remained the same. Heidenhain[5] corroborated this work, and reached the same conclusion. Cohnstein[6] noted some increase in the flow of lymph from the thoracic duct after introducing fluid into the abdominal cavity, but thought it entirely out of proportion to the amount absorbed. His results in the main, however. agree with those of Orlow and Heidenhain. Klapp[7] also concluded from his experimental work on dogs that soluble substances are absorbed from the peritoneal cavity chiefly through the blood-vessels. This imposing array of evidence seems quite convincing until one comes to consider the contribution of Meltzer[8], who, contrary to Starling and Tubby and Mendel, observed that solutions of coloring matter introduced into the peritoneal cavity appeared earlier in the thoracic duct than in the urine, and especially the more elaborate communication of Adler and Meltzer.[9] These authors concluded from numerous experiments that ligation of the lymphatic ducts in rabbits does exert a restricting influence upon the quantity of fluid disappearing from the abdominal cavity, but that such experiments do not indicate whether or not the lymphatics carry away a part of this fluid. They found further that potassium ferrocyanide and strychnine are carried away mainly, if not exclusively, by the lymphatics. Their criticism of the work of Hamburger, Orlow and Heidenhain is, it seems to me, well-founded; and I quite agree with them that the conclusions of these authors are not justified from their work. They very cleverly point out the possibility of the interstitial tissue spaces as a system to be considered independently of the blood-vessels and the lymphatics, into which fluid may enter from the peritoneal cavity by filtration and osmosis; that from here it has three avenues of escape: (1) it can spread into the interstitial spaces of neighboring regions, and either not affect the blood- and lymph-vessels at all, or affect the blood-vessels sufficiently to reduce transudation into this region; (2) it can enter the blood-vessels through the walls of the capillaries or veins; (3) it can enter the lymphatics through the walls of the lymph capillaries. They call attention further to the fact that the contents of the thoracic duct may be quite different from the tissue fluids, the latter being a mixture of at least three components, viz., transudate from the blood-vessels, this minus the elements used in anabolism, and the products of catabolism. It becomes evident, therefore, that the interstitial tissue spaces may be conceived of as a system of reservoirs into which fluids or solutions of coloring matter are poured from the peritoneal cavity, probably largely by filtration and osmosis; and further, that the conclusions of Hamburger, Orlow, Heidenhain and others, based upon experiments which assume that the disappearance of these substances from the peritoneal cavity is equivalent to their direct and immediate transfer either to the lymph or blood capillaries, and which utilize the flow of lymph through the thoracic duct as an accurate indicator of the extent to which the lymphatic system participates in the process of absorption, are entirely unwarranted.

It seems to me highly probable that both the lymph and blood capillaries participate in the removal of fluids and soluble substances from the interstitial spaces, but that the experimental work thus far done does not warrant a dogmatic statement that either system is entirely concerned in the process to the exclusion of the other. It must be remembered, too, that it has been repeatedly shown that the pressure in the peripheral veins is considerably greater than that in the lymphatic vessels—the latter constituting a system of drainage channels with a pressure approaching that in the great vessels near the heart; and that the pressure in the interstitial spaces is probably somewhere between that in the peripheral veins and the lymphatic vessels; a fact which acquires added significance when it is undertaken to show that the chief absorption of fluids is through the venous channels.

In this connection it is well to recall further that it has now been definitely established through the work of MacCallum,[10] Kolossow,[11] Muscatello,[12] and others that the endothelial covering of the peritoneum is continuous, and not perforated by numerous *stomata* and *stigmata*, or direct channels of communication between the peritoneal cavity and the lymphatic vessels, as was until quite recently generally taught.

Closely allied with its remarkable absorptive power, is the well-known ability of the peritoneum to successfully cope with an astonishing amount of infection without itself being seriously or permanently damaged. It has been repeatedly shown that enormous numbers of virulent bacteria in pure culture can be injected directly into the peritoneal cavities of dogs without producing any serious consequences. And, as everyone knows, during the course of a large percentage of abdominal operations the peritoneum becomes soiled with bacteria, the destruction of which the surgeon confidently leaves to nature. Another familiar characteristic of the peritoneum is the remarkable variation in sensibility exhibited by different portions—in a general way the visceral part being entirely insensitive to pain, pressure, heat and cold, while the parietal portion is everywhere exquisitely responsive to these sensations. This was elaborately worked out by Lennander.[13] Cushing[14] had previously called attention to the fact that this same difference holds true for inflamed as well as healthy peritoneum, an observation that has been frequently corroborated by others since. Samson [15] observed during the course of operations upon the lower end of the ureters that they are painless when pinched, cut, or sutured, unless traction is exerted on the parietal peritoneum. Broese[16] very recently corroborated Lennander's views with reference to the pelvic organs in a most convincing way. In a case of vaginal fixation of the uterus, done under local anæsthesia, he found that the ovaries, tubes, and body of the uterus are insensitive to pain, pressure, heat, and cold. He amputated the tube and resected the uterine cornua without discomfort to the patient. But any traction, such as was required to deliver the uterus into the vagina, was extremely painful. Mitchell[17], whose large experience in laparotomy under local anæsthesia entitles him to speak with authority upon this subject, has just published an excellent review of the literature of the past ten years, together with some very interesting observations of his own. It is quite evident from his paper that the controversy is still going on actively between the adherents and opponents of Lennander's views. His conclusions accord with the latter, and furthermore, he met with an encouraging measure of success in systematically analyzing abdominal pains before laparotomy, in an effort to diagnosticate both the location and the cause of this sensation. The recently conducted elaborate dissections of Ramström[18] have gone far toward furnishing us with the much-desired anatomic basis for this remarkable difference, so strikingly shown in the course of laparotomy under local anæsthesia. If post-operative adhesions are oftentimes unavoidable, let us, therefore, in the light of these observations, strive to limit their formation to the viscerovisceral, rather than the visceroparietal variety, for the double reason that the former are not only painless but, generally speaking, far less dangerous.

One of its most striking characteristics is the rapidity with which the peritoneum can form adhesions—a piece of gauze introduced into the abdomen during the course of an operation becoming quite snugly fixed to the visceral surfaces within a period of twenty minutes; a fact that is daily taken practical advantage of by surgeons in the disposition of protective gauzes during operations upon infected areas, and which adds materially to the sense of security afforded by gauze pads alone. This characteristic is also very intimately involved in the whole question of peritoneal drainage; and it constitutes further one of nature's admirable methods of protection against disastrous peritoneal damage, as exemplified in the walling off of an appendix abscess.

Finally, perhaps less striking but to my mind even more remarkable, is the completeness with which the peritoneum may absorb adhesions, and, indeed, completely eradicate all traces that would indicate their previous existence. I am convinced that it is a perfectly safe assertion to make that adhesions invariably follow laparotomy, and yet how common it is nowadays to find at a later second laparotomy no traces of them whatever.

Now, obviously, all of these fundamental and important characteristics of the peritoneum must be reckoned with in studying the process of adhesion formation and in any attempt to control or prevent it. Happily we now know, as a result of much careful experimental and clinical study, quite accurately the pathological changes involved. Wegner,[19] in 1877, made a lengthy report of elaborate researches into the histological changes occurring in the peritoneal endothelium under a variety of experimental conditions. One rather unique experiment of his was to blow air into the peritoneal cavities of rabbits over a period of one month, observing the effects after varying intervals of time. He found fatty changes in the endothelium after four days, which later—after eight or ten days—changed to scar tissue, but produced no adhesions. Graser[20] described in detail, with illustrations, the early histological changes occurring in aseptic wound healing of the peritoneum. He showed that after injury to the endothelium, the denuded surfaces lie together by reason of the agglutinating properties of the exudate, which later, through the growth of spindle-cells, becomes changed into vascularized connective tissue, and terminates in the parts becoming grown fast together. More recently Hertzler[21] published observations on the formation of peritoneal adhesions made in a rather novel way, namely, through a small glass window sewed into the abdominal wall of the animal. He concluded that peritoneal surfaces may agglutinate without destruction of the endothelial layer; but that in true adhesions the endothelium is always destroyed. If, however, the basement membrane is not destroyed also, he believes that the adhesions may later separate; otherwise, the union is rendered permanent through the formation of fibrous tissue. It would seem, therefore, that the pathological changes involved in the process of adhesion formation in the peritoneal cavity are, in order of sequence: (1) injury or death of the surface endothelium; (2) pouring out of coagulable exudate; (3) agglutination; (4) organization; (5) fibrous tissue formation, which terminates ultimately in (6) a contracted scar. Observe that the whole process is dependent upon and subsequent to injury to the surface endothelium.

It is not surprising, then, to find the bulk of the literature on the etiology of adhesions concerned with a study of the various agencies ordinarily coming in contact with the peritoneum that might be considered inimical to the vitality of its endothelium. For the sake of brevity and clearness we may classify these contributions according to subject-matter as follows: (1) blood; (2) sutures and ligatures; (3) eschar of the thermocautery; (4) air; (5) infection; (6) mechanical, chemical and other agents.

Blood.—The final verdict has not yet been given regarding the relationship of free blood in the peritoneal cavity to adhesion formation. Penzoldt[22] published, in 1876, the results of a very elaborate experimental research into the fate of large amounts of blood in the peritoneal cavity, showing that it is absorbed. Wegner[19], in 1877, and later Vogel[23] observed the same thing experimentally. V. Dembowski[24], in 1888, reported the results of a large number of carefully executed experiments on adhesion formation in the peritoneal cavity, and concluded with reference to blood-clots, that they do not provoke adhesions. Gersuny[25], on the other hand, after studying a group of cases exhibiting a constant type of adhesion about the sigmoid ("flexur adhesion"), thinks that bleeding from ovulation or tubal menstruation may be the cause. Zweifel[26] and his school—*vid.* Füth[27]—strongly advise the removal of all blood from the peritoneal cavity in cases of ruptured ectopic pregnancy. Fromme[28] reported, a few years ago, the results of very elaborate and painstaking experiments on rabbits designed to test, (1) the effect of blood alone, and with serous defects in the peritoneal cavity; and (2) of infected blood alone, and with serous defects; using for this test pure cultures of common bacteria. He concluded that in the vast majority of cases neither blood alone nor with peritoneal defects produces adhesions. Furthermore, some of the cases with infection added showed none, although the majority of these did develop adhesions, especially those with raw peritoneal surfaces. Fromme quotes Biyl as having reached the same conclusions experimentally a few years before. Flateau[29] opposes the views of Zweifel's school, and leaves all the blood in the peritoneal cavity in cases of ruptured extra-uterine pregnancy that does not escape as a result of necessary operative manipulations. He condemns all efforts to remove it on the ground that it is impossible to get it all out, and that attempts to do so only serve to prolong the operation and to injure the peritoneum. Baisch[30], on the basis of his experimental work, concurs with the view that the peritoneum is capable of absorbing large amounts of blood without resulting adhesions, if intact, but finds that whenever a serosa-free surface is present it always leads to adhesions.

My own experience leads me to believe that the blood originating from rupture or abortion in cases of ectopic pregnancy does not produce peritoneal adhesions. The pelvic adhesions so commonly found in these cases are to be explained much more rationally, it seems to me, on the probability of associated or pre-existing infection, or as attributable to irritation induced by the development of the gestation sac. I have frequently observed cases in which the abdomen had been filled with a mixture of blood and serous exudate for periods of twenty-four hours or longer, and yet at operation it was seen that the peritoneum had not even lost its gloss. It is my deliberate judgment, therefore, that blood alone does not cause peritoneal adhesions, but that when it is associated with infection or trauma, its presence is to be regarded as an adjuvant to their formation.

Sutures and Ligatures.—The ultimate fate of aseptic sutures and ligatures in the peritoneal cavity and their relationship to adhesion formation have been carefully studied by a number of workers. Hallwachs[31], in 1879, showed with good experimental work that non-absorbable sterile ligatures in the peritoneal cavity first produce a circumscribed inflammatory reaction, then become covered with a thin layer of granulation tissue, and being thus isolated from surrounding structures, become gradually disintegrated and are removed through the agency of the tissue juices and leucocytes. Spiegelberg and Waldeyer[32] had earlier, in 1868, noted the harmlessness of aseptic ligature material in the abdomen. Rosenberger,[33] Tillmans,[34] tenBrink,[35] Kelterborn[36] and others later confirmed these observations. V. Dembowski,[21] on the contrary, concluded from his experiments that all sutures act as foreign bodies and cause firm adhesions along their lines of insertion; but his work was not convincing to later investigators. Stimson,[37] in 1889, called attention to the dangers of mass ligatures, and recommended substituting individual ligation of vessels in pedicles, and covering the latter with peritoneum. Klotz[38] found in six cases relaparotomized for ileus each time a loop of small bowel adherent to a pedicle stump. I recall very distinctly a case of post-operative ileus, observed a few years ago during my hospital apprenticeship in the department of Dr. H. A. Kelly at Johns Hopkins Hospital. A simple interval appendectomy had been done by one of the members of the House Staff. The usual technic of the department had been employed—*i.e.*, amputation by the clamp and cautery method, inversion of the stump, and securely tying a purse-string suture previously placed about the base. Only, in this instance, owing to the insignificant size of the meso-appendix pedicle stump, the usual custom of covering it over had been omitted. At the second operation, performed within forty-eight hours, I found a band of omentum quite snugly fixed to this little mesenteric stump and obstructing the ileum. Rubin[39], in his report of an elaborate pathological and experimental study of the functions of the great omentum, published only a few months ago, concluded, with reference to omental adhesions to the abdominal incision, that they are best prevented through a carefully introduced continuous catgut suture. Neuhof and Wiener [40] also very recently published the results of a most interesting and instructive experimental study of omental adhesions. They showed that the omentum is capable of insinuating itself into needle punctures, and through the small gaps between peritoneal sutures, and of adhering to these minute raw surfaces. It is obvious how easy it would be for a less careful observer to attribute such findings to the presence of the suture itself. It seems to me definitely proven, then, that when one exercises good surgical judgment in the choice of aseptic sutures and ligatures, and manual dexterity in their application, together with proper attention to covering up pedicle stumps, no grave fears need be entertained as to troublesome adhesions arising from this source.

Eschar of the Thermocautery.—The results of the experimental work on the use of the thermocautery in the peritoneal cavity have been somewhat conflicting. Thus Spiegelberg and Waldeyer,[32] v. Dembowski,[24] Franz,[41] and Maslowski[42] found that it produces adhesions. Baisch[50] and Kelterborn,[36] on the other hand, were unable to confirm this work. TenBrink[35] produced adhesions with the cautery only when infection was present. Küstner[43] reports in detail a case in which a large ovarian cyst, with many pelvic adhesions, was removed, the actual cautery being used to sever the adhesions and also the pedicle of the cyst. At a second operation fourteen months later for post-operative hernia no adhesions were found where the cautery had been used. A possible explanation of these conflicting reports is to be found in Vogel's[23] excellent monograph. He found that a superficial burning of the peritoneum generally gives rise to adhesions, but that none occur after a thorough cauterization with the formation of a thick eschar. As long ago as 1877, Wegner[19] explained the formation of peritoneal adhesions as analogous to healing by first intention, and Vogel, with this idea in mind, ascribes their failure to materialize, after a deep eschar or a severe chemical injury is produced, to the fact that the layer of necrotic tissue prevents primary union; or, in other words, the charred surface protects the underlying granulations from contact with neighboring structures long enough for them to become covered with new endothelium. Webster[44] corroborates Vogel's claims, and advocates very thorough cauterization to produce a black char. Whether or not this explanation is correct, the weight of experimental and clinical evidence certainly warrants the thorough application of the cautery when indicated, with far less likelihood of adhesions ensuing than if certain other procedures applicable to the same conditions are substituted.

Air.—Exposure of the viscera to the air is recognized, of course, as one of the cardinal factors in the production of surgical shock. It may not be so generally known, however, that very elaborate and interesting experiments have been carried out to ascertain the exact effect of air on the peritoneal endothelium and its relation to adhesion formation. Reference has already been made to Wegner's unique experiment of blowing air into the peritoneal cavities of rabbits over varying periods of time, thereby producing decided changes in the surface endothelium, even to complete substitution by scar tissue, but observing no signs of adhesions develop. Walthard's[45] experiments have been much quoted in this connection, because of the great care and thoroughness with which they were conducted. No one can read this communication without being impressed by these facts, as well as by the significance of his conclusions. In his first series of experiments he performed supravaginal hysterectomy on a number of rabbits, carefully avoiding mechanical injury to the peritoneum of the uterovesical pouch by not touching it at all; he freely exposed it to the air, however, and at the autopsies, some days later, he found adhesions in every case between the surfaces of the uterovesical peritoneum. In the next series he brought the uterus out through a laparotomy wound, and very carefully protected it, as well as the surrounding parts, with gauze pads moistened with hot salt solution; he kept the moisture, temperature, and protection as nearly constant as possible. At the end of the experiment the uterus was returned to the peritoneal cavity and the wound closed. Later post-mortem examinations showed no adhesions and no exudate in any case. Next he tested in cats the effect of air contact on isolated areas, by exposing a loop of bowel, part of the omentum, or the posterior part of the bladder peritoneum to the air for twenty minutes. Twelve days later at autopsy every case showed adhesions between the bladder peritoneum, omentum, and incision. The intestine, however, did not adhere in any of these animals. In an equal number of control animals, protected with moist hot gauze, no adhesions occurred. In a very ingenious way he then exposed the peritoneum to air filtered free of dust and infection, and found that adhesions resulted under absolutely aseptic conditions. He then tested the effect of steam at 38° C. on the peritoneum and found that it produced no adhesions. Next he tested the chemical action of component parts of the air (O—Co_2—N) and found that none of them produced adhesions, if moisture was present. Dry air at 38° C.

produced both adhesions and macroscopical changes in the peritoneum. He concluded from these results that the damaging influence of air on the peritoneum is not dependent upon the presence of dust and infection, but when freed from these and in a state of dryness, its prolonged contact with the normal serosa produces a necrosis of its endothelium by cooling, with resulting contraction of the blood-vessels and consequent diminished nutrition, leading finally to adhesion formation. He believes, further, that long exposure to air lowers the resistance of the peritoneum, so that the number of bacteria necessary to produce fatal peritonitis is greatly reduced. His experimental deductions are borne out clinically in 146 laparotomies on human beings for various causes, in that not only no adhesions clinically discoverable occurred, but also much less post-operative flatulence was seen. The year following Walthard's publication Schiffer[46] reported from Sanger's clinic a marked falling off of ileus cases following the introduction of moist asepsis. In 132 laparotomies with dry asepsis, there were 10 deaths, 5 of which were due to intestinal obstruction. In 76 cases with moist asepsis there were 2 deaths—both cases of ruptured ectopic pregnancy—and no ileus. He further noted much less post-operative discomfort, vomiting, and thirst. A few years later Uhlmann's[47] paper appeared based upon a very careful study of the material of Zweifel's clinic, and contradicting every essential point claimed by Walthard and Schiffer. Thus flatus was passed on the second day by both the dry and wet aseptic cases. Likewise the bowels moved on the third day alike in both classes of cases. Only one fatality from ileus occurred in 481 laparotomy cases with dry asepsis, although 18 (3.3 per cent.) of these did have intestinal disturbance; while in 80 cases with moist asepsis, 4 (5 per cent.) had severe intestinal disturbance. Operative peritonitis with death occurred in 0.6 per cent. of the cases during the period of dry asepsis and 1.25 per cent. during that of moist asepsis. Flatus passed and the bowels moved within the same period of time both in those cases which were eventrated at operation, and those in which the intestines were left *in situ* —a fact which the author thinks casts doubt on Walthard's idea of deleterious effect of the air drying the peritoneum. In 23 cases relaparotomized—some of whose first operations had been done with antiseptic, some with dry aseptic, and some with moist aseptic technic—post-operative adhesions were found, but were always to be accounted for by trauma, and nowhere were adhesions found between two serous surfaces entirely uninjured at the first operation. Adhesions between loops of bowel were not more frequently encountered in the cases that had been eventrated than in the others of the relaparotomized series; a fact which the author thinks disposes of Walthard's idea of air damage. Furthermore, no connective-tissue thickening of the serosa was found in places where the surfaces were damaged at the first operation, but did not lie in contact long enough to adhere, and Uhlmann thinks that this does not occur when only the endothelium is injured. Although adhesions were found in all of the 28 cases relaparotomized, only 6 of these had shown intestinal disturbances—a fact which the author thinks shows how inaccurate the test of intestinal obstruction is as an index of the frequency of adhesions following any special operative procedure. He finds support of his criticism of Walthard's ideas in Fritch's[48] report of 52 laparotomies conducted with moist warm aseptic technic, furnishing two cases of ileus with one fatality, and concludes that the claims of Walthard and Schiffer are not proven, and should be tested further before the older methods are abandoned.

Now, in drawing conclusions from these reports as to the relative value of moist and dry asepsis, it must not be forgotten that nothing brought out in this clinical study of Uhlmann's invalidates in the least the experimental results of Walthard. It is of fundamental importance, too, to remember that the formation of post-operative adhesions does not depend solely upon the principles of technic involved respectively in moist and dry asepsis. Before a just comparison can be made clinically of results obtained by the two methods, therefore, it becomes necessary to exclude absolutely all other factors involved in the production of adhesions. It is manifestly illogical to throw together two heterogeneous groups of cases that have been laparotomized for a variety of conditions, and to ascribe the resulting difference in adhesion incidence solely to the factors involved in dry and moist asepsis. Such studies as those of Schiffer, Fritch, and Uhlmann, therefore, while furnishing most interesting and instructive data, are of very little value in determining the point at issue; and it seems to me that Walthard's experimental results render it imperative that surgeons should employ moist asepsis as far as practicable in the abdomen, at least until they are more successfully assailed than by the criticisms thus far brought forward. Thus, aside from shock, we have an additional very important reason for carefully protecting all parts of the peritoneum from undue exposure during the course of abdominal operations, namely the prevention of adhesions.

Infection.—No one doubts, of course, that infection produces adhesions. But there seems to be much difference of opinion as to the formation of adhesions without infection. Martin[49], as far back as 1888, made an exhaustive study of a series of cases requiring relaparotomy, and called attention to the increased difficulties of the second operation on account of intestinal adhesions to the anterior abdominal wall so commonly encountered. A number of observers—v. Velits,[50] Koblanck,[51] Huth,[52] Pernhorst,[53] Steffens,[54] and others—have since called attention to the gradual falling off in the number of adhesion cases seen in the clinics corresponding with the improvement in surgical technic. Some have interpreted the remaining incidence, however, as conclusive evidence that our methods are still imperfect as regards asepsis. Steffens's excellent contribution, based on a very thorough study of 45 patients relaparotomized, is worthy of more than passing notice. He found that more or less general adhesions were encountered at the second laparotomy in every case that had exhibited an elevation of temperature following the first operation. Pernhorst also noticed this fact, and thinks that post-operative elevation of temperature is an indication of adhesion formation. Fritsch[48] showed from a study of relaparotomized patients that adhesions occur in spite of the most careful technic. Reichel[55] concluded from an elaborate experimental, clinical, and bacteriological study of ileus that infection is the chief cause of this condition, and that it may produce very few clinical symptoms, and little or no change in the peritoneal surface. He thinks that the infection may be limited to one loop of bowel, and that the resulting interference with peristalsis is the chief cause of adhesions. Kelterborn's experiments led him to believe that peritoneal adhesions are due to infection always. V. Braun-Fernwald[56] and also Jesset [57] later came to the same conclusion. The year following Kelterborn's report, Thompson[58] published the results of a large number of experiments on cats, dogs, and rabbits, carried out with the most elaborate precautions against all possible sources of infection, even going so far as to sterilize the air of the operating room. He found that omental and intestinal adhesions follow perfectly aseptic laparotomies, even when the abdominal wound is shown to be sterile. Fromme believed, from his very creditable experimental work, that peritoneal adhesions are due chiefly to infection, but that they can occur without it. The work of the several investigators referred to in the last section is in full accord with this idea. It is evident, therefore, that the alignment can be sharply drawn between the adherents of two views: (1) those who hold that infection is the sole cause of peritoneal adhesions; and (2) those who believe infection to be a frequent cause, but contend that adhesions will also result from a variety of other causes acting independently or collectively. To my mind the evidence given above establishes beyond doubt the correctness of the latter view.

Mechanical, Chemical and Other Agents.—During the period of transition from antiseptic to aseptic surgical technic, considerable discussion is to be found in the literature regarding the relationship of the former to adhesion formation in the peritoneal cavity. V. Dembowski [59] claimed to have injected strongly irritating substances, *e.g.*, turpentine, into the abdomen without producing adhesions. He was also unable to produce them by such violent mechanical irritation as rubbing the peritoneal surface with a stiff tooth-brush; and even after deliberately excising islands of peritoneum together with the underlying fascia, he caused no adhesions. The omentum was adherent to the abdominal scar, however, in all of his animals; and he found, further, that gauze or other foreign bodies, introduced into the peritoneal cavity, always produced adhesions. Delbet, Grandmaison and Bresset,[60] on the other hand, published in 1891 the results of experiments which demonstrate very clearly the harmfulness to the peritoneum of such antiseptic solutions as carbolic and salicylic acids, bichloride and biniodide of mercury, and that they predispose to adhesion formation through their irritative action. Iodoform and salol, they found, have very little irritating effect. Klotz[38] reported a decided falling off in the number of post-operative ileus cases following the substitution of aseptic for antiseptic technic. Thompson[58] found that sterile foreign bodies, such as gauze, cause adhesions in the peritoneal cavity, if large enough to cause irritation. Tinker[61] recognizes gauze drains and packs as common offenders in producing adhesions. Pankow,[62] in testing the relationship of denuded peritoneal surfaces to adhesion formation, was able to produce adhesions in only one-half of his cases by stripping the parietal peritoneum sufficiently deep to cause multiple punctiform hemorrhages. Franz found no adhesions following aseptic peritoneal defects. Sänger[63] concluded, from operations in which portions of the parietal peritoneum were resected, that one wound surface is sufficient to produce adhesions, which inevitably follow, and that it is not necessary for two such areas to lie together for their formation. Klotz[38] states that post-operative ileus develops if an epithelial-free bowel surface, either through direct or indirect misplacement, lies in contact with a wound surface; and that the formation of adhesions is favored by the presence of blood Rissmann[64] concluded from experiments on cats, dogs, and rabbits that many adhesions occur accidentally in experimental work which are not intended; he differentiates seroserous adhesions, which form without sepsis, chemical or mechanical irritation, from the dense union caused by local infection, possibly through chemical or mechanical irritation, and surely through apposition of the bared subperitoneal connective-tissue layer with the normal peritoneum. He considers that the first type are easily loosened, but that the latter remain much longer, their exact duration not being known. Neuhof and Wiener[40] found that under aseptic conditions the intact omentum always adheres to foreign bodies and to raw surfaces within its reach, whether parietal or visceral; that it always adheres by its free edge; that when resected it always adheres by the remaining intact edge; that a raw omental margin may adhere a certain length of time—possibly a week—after resection of the edge, and that such adhesions occur independently of peritoneal denudations or of foreign bodies; and that when infection is present not only the edge but the surface of the omentum becomes broadly attached by a thick exudate, even when the edge has been excised. Rubin's[39] exhaustive study of the function of the great omentum, already referred to, brought out some interesting factors involved in adhesion formation usually not mentioned in this connection. Thus he reminds us that the omentum possesses no spontaneous motility, and that its displacements are to be explained by: (*a*) intestinal peristalsis; (*b*) intra-abdominal tension; (*c*) static condition of the stomach, colon, and small bowel; and (*d*) its anatomical relationship to the gall-bladder and spleen. Further, that it possesses no demonstrable chemotaxis; the phenomena usually attributed to this property being in reality due to the presence of intraperitoneal fluid, gas in the large bowel, or the suction action of the diaphragm. And that its value in inflammatory conditions depends upon its power to form adhesions which isolate and render innocuous toxic products through absorption and elimination, or destroy them through the agency of its phagocytic elements. Ward[65] in his unusually clear and scholarly review summarizes his views with reference to the etiology of peritoneal adhesions as follows: "We may lay down the statement that the formation of peritoneal adhesions after operation is directly proportional to the amount of sepsis, traumatism, dry air contact, loss of heat, and raw surface there is present." It is evident, therefore, that abundant experimental proof is available to support the generally accepted view that raw surfaces and other less severe injuries resulting from direct mechanical insult to the peritoneum furnish one of the commonest, if not the most frequent, causes of adhesions. In this connection, moreover, too much emphasis cannot be given to the importance of exercising the utmost care and gentleness in all intraperitoneal manipulations. Rough handling of the viscera; unintelligent, and I might say sometimes almost brutal, use of retractors and other instruments; mauling the bowel surface by the introduction of innumerable gauze pads, which, to be sure, add materially to the comfort of the operator, but more to the distress of the patient; the application of dry gauzes to the peritoneal surfaces, which generally adhere and when removed often bring away with them the surface endothelium; unnecessary sponging, as a sort of surgical tic or habit-spasm; careless application of hæmostats, with painful indifference to the mass of crushed tissue left to necrose in the grip of the ligature—all of these constitute transgressions of which few of us can claim innocence. But they also constitute a prolific source of adhesions, and should, therefore, be constantly borne in mind, in order to impress upon ourselves the value and importance of diligently cultivating a healthy aversion to unnecessary trauma, and a profound respect for the tissues.

In the beginning of this paper I ventured to predict that peritoneal adhesions will of necessity always remain an inevitable part of abdominal surgery. I wish here to call attention to the fact that the soundness of the reasoning adduced in support of this proposition has been clearly established through the cumulative evidence that has steadily accrued in support of it throughout the detailed discussion of this whole subject. I stated, further, that it will be found in the last analysis that in the intelligent management of peritoneal adhesions, the abdominal surgeon has recourse to three classes of procedures, namely, (1) measures which prevent adhesions; (2) measures which restrict their formation to the harmless variety; and (3) measures which aid in their absorption. Now it will become apparent from the following consideration of the prevention and treatment of adhesions to which of these classes each procedure thus far suggested belongs.

In the first place, certain prophylactic measures at once suggest themselves as being clearly indicated from what has already been said. Briefly stated, these are: rigid asepsis; avoidance of mechanical, chemical, or thermic trauma; careful covering over of all denuded surfaces; use of moist hot gauze; avoiding exposure of the peritoneum to air. Thus far practically everyone is agreed. But the common experience that troublesome and dangerous adhesions still quite frequently occur, in spite of the strictest possible observance of these measures, has led investigators to undertake the most varied and elaborate researches with the hope of discovering some prophylactic or remedial agent that would prove efficacious in all cases. As I have already pointed out, this is a vain hope, and such efforts are fundamentally wrong. Nevertheless, this work has resulted in the production of many ingenious and valuable procedures, all of which have at one time or another been enthusiastically advocated, and have received varying degrees of support from the profession generally. The reports of these heterogeneous devices can be conveniently grouped and discussed as follows:

Non-absorbable Protective Membranes.—From time to time investigators have attempted to prevent adhesions to raw surfaces by covering them over with films of some foreign substance that would serve as a protective membrane and that could be kept in position until the endothelium had regenerated. Thus Stern,[66] in 1889, experimented with collodion for this purpose; he warmly recommended it for covering pedicle stumps, but otherwise was unsuccessful with it. Wright[67] used a gelatin-formalin coagulum; his technic was to cover oozing surfaces with a 15 per cent.–20 per cent. solution of gelatin, to which 1 per cent.–2 per cent. formalin was added; this caused the gelatin to form a coagulum in a short time, and to become fixed to the raw surface. Its use has not met with general favor, however. Morris[68] claimed from his experiments on rabbits that he found aristol to be insoluble in serous fluids, and that when dusted over raw surfaces it quickly forms a protective covering, with the aid of the coagulated lymph, which cannot be brushed off. He strongly advocated this lymph-aristol coagulum as a valuable anti-adhesion measure. Ellis[69] tested this idea on dogs with a number of different substances, including silver-foil; formalin-gelatin mixture; solutions of gutta-percha in (*a*) chloroform, (*b*) carbon bisulphide, (*c*) xylol; and thin sheets of collodion, sterilized and hardened in bichloride of mercury. He reported failures with all of these substances, except the last, and regarded it as impracticable for use in the abdomen, because it cannot be held in position. It is very evident from the reports that none of these substances can be relied upon to furnish more than a small percentage of successful results, and, on this account, cannot be recommended for general use.

Manual and Postural Arrangement of the Viscera.—This is accomplished partly through proper disposal of the viscera with reference to normal anatomical relationship, at the end of the operation, and partly through post-operative posture in the ward, with the double idea of avoiding permanent kinks at those parts of the gastro-intestinal tract which are known to cause trouble, and for the further purpose of preventing contact with raw surfaces by gravitating the abdominal contents away from them. Tinker,[61] in a paper replete with practical suggestions, in addition to the commonly accepted procedures, emphasizes the thorough ante-operative evacuation of the bowels; post-operative posture to gravitate the abdominal contents away from raw surfaces for four or five days; avoidance of flatulence by stimulating peristalsis with strychnine and eserine; restricted and easily digested food; intestinal antiseptics; the importance of withholding morphine; the employment of stupes and enemata; and getting patients out of bed early. Clark[70] reminds us, in a very forceful contribution, that certain anatomical considerations are of fundamental importance in connection with the problem of peritoneal adhesions. Thus he condemns the use of the omentum for the prevention of adhesions when it will thereby fix or drag down the stomach or transverse colon; because it causes gastric disturbance in the former event, and obstinate constipation in the latter. He further points out those movable parts of the gastro-intestinal canal that commonly produce untoward symptoms, if permanently kinked—especially the pylorus, duodenum, upper jejunum, pelvic loop of the ileum, cæcum, transverse colon, and sigmoid; and enjoins care in replacing the viscera in their proper relationship, especially where ptosis exists. Finally, he recommends the routine use of large enemata of hot salt solution at the end of abdominal operations, in order to fill the colon; which not only adjusts the latter properly, but further serves as an internal hot water bag applied directly to the sympathetic nervous system and great vessels, thus preventing shock, tympanites and adhesions, as well as stimulating the kidneys.

It seems to me that this idea of manual and postural arrangement of the viscera according to normal anatomical relationship is worthy of especial emphasis. Not only should it be employed as a routine measure, but it applies with particular fitness to that large group of cases in which we have no hope of successfully and completely preventing adhesions, and where, therefore, our choicest alternative is to restrict them to the harmless variety. Every surgeon is longing for some discovery that will dispel the dread and reluctance with which he approaches those miserable unfortunates, seen in every clinic, whose abdominal walls look like a patch-quilt from the scars of numerous laparotomies, who possess no vestige of endothelium on their parietal peritoneum, and whose viscera seem hopelessly entangled in an interminable meshwork of adhesions. We reluctantly add another scar; we painfully and aimlessly dissect in various directions from whatever starting point our incision affords; and this we continue until the patient's collapse forces us to desist, when we gloomily close the abdomen, conscious of two things: namely, that we have not helped the patient, and that the same performance will, ere long, have to be repeated either by ourselves or some unfortunate colleague. Now would it not be wiser to study the situation a little more closely beforehand, especially from the anatomical stand-point to which Clark has drawn attention, and to determine clinically, if possible, which zone of adhesions is responsible for the chief trouble; then to assemble our most trustworthy methods, and to concentrate our operative attack upon an intelligent effort to restore normal anatomical relationship, and to restrict such adhesions as must of necessity follow to areas where they will either aid in the accomplishment of this purpose or else can do no harm?

Peristalsis.—Considerable work has been done on the early post-operative administration of various cathartics, with the idea of stimulating strong peristalsis, and thus liberating early adhesions as well as preventing their recurrence through constant motility of the bowel. Klotz[38] reports successful results in treating acute post-operative obstruction by gastric lavage with four to six quarts of warm salt solution, followed by the introduction of one and one-half to two ounces of castor oil through the stomach tube. He considers it useful only in obstruction from fresh adhesions. Cumston[71] recommends, in a clinical lecture on adhesions, the hypodermic administration of physostygmin for several days following laparotomy, with the idea of constantly changing the peritoneal surfaces in contact through peristalsis. Byford[72] and Paton[73] also recommend early catharsis with the same idea in view. Vogel[23] obtained a fair measure of success experimentally with physostygmin as an anti-adhesion measure. V. Hippel[74] considers this drug a valuable post-operative agent in preventing adhesions and ileus and recommends it highly. Busch and Bibergeil,[75] on the contrary, found experimentally that this drug is not efficacious in preventing adhesions. Uyeno[76] saw no effect on adhesions experimentally produced in rabbits by irritants (iodine, and dilute acid, and alcohol) from the use of phyostygmin. But systematic massage effected degeneration and absorption of them in most cases, leaving the intestinal coils free from each other. Conflicting opinions appear to be held, therefore, with reference to the value of early stimulation of peristalsis as a prophylactic measure against adhesions. It seems to me that it can scarcely be recommended as a routine procedure, but that in properly selected cases, dependent upon a number of obvious considerations, it is of distinct value.

Specific Drugs.—Already some observers have attempted to deal with peritoneal adhesions through the specific action of certain drugs in the body. Eastman[77] recommends the administration of iodides, in the form of the syrup of hydriodic acid, claiming that it inhibits the proliferation of connective tissue and aids in the absorption of adhesions. Thiosinamine, and its combination with salicylate of sodium, known as fibrolysin, have been accredited with possessing a softening influence upon cicatrices, and other abnormal growths of connective tissue. Offergeld,[78] with a full review of the literature, reports only failures in the treatment of peritoneal adhesions with this drug, after giving it a thorough trial, with close observations, in 55 cases. Busch and Bibergeil[75] tried the introduction of fibrolysin dissolved in salt solution directly into the peritoneal cavity, but found that it was absorbed too rapidly to be of any noticeable value. Michael,[79] on the other hand, reports most favorable results in the treatment of two cases of perigastric adhesions with it. Sidorenko[80] has just reported the results of a clinical, experimental, and histological study of fibrolysin on cicatricial tissue. From a critical study of the results of other workers, and from his own results, he concludes that it does not exert any therapeutic effect upon cicatricial tissue. Hertzler[21] tried to diminish the coagulability of the blood, with the idea of preventing agglutination through the transformation of the exuded serum into fibrin—the first essential stage in adhesion formation. He used (*a*) phosphorus by mouth, because it destroys fibrinogen and thus prevents coagulation; and (*b*) peptone hypodermically, because it neutralizes the fibrin ferment in the blood. He claims absolute success with phosphorus. Marvel[81] recommended introducing adrenalin into the peritoneal cavity in warm salt solution to prevent adhesions, claiming that it dissolves the peritoneal exudate and thus aids in its absorption; and further, that it prevents subsequent exudation by stimulating vasoconstriction and thus shutting off leakage. It appears, therefore, that an encouraging measure of success has attended these pioneer efforts to apply specific chemotherapy to the problem of peritoneal adhesions, and it seems to me that further development along this line is to be confidently expected, inasmuch as the possibilities of this important field of research are just beginning to be recognized and to attract wide-spread attention.

Normal Salt Solution.—Large quantities of physiological salt solution poured into the abdomen at the end of the operation in order to float the loops of bowel into their normal relationship and to keep denuded surfaces separated was at one time extensively used. Müller,[82] in 1886, was the first to recommend this measure, although Malcolm[83] independently advocated the same thing in 1890. Stern[66] concluded from his experiments that the formation of adhesions was not hindered by this procedure. Morris[68] came to the same conclusion, and explained the failure as being due to rapid absorption of the fluid. This view has since been abundantly corroborated, and there is no evidence to show that new growth of endothelium over raw surfaces occurs to any considerable extent before the fluid is absorbed and they are again in contact. Cumston[84] actively opposes its use not only for this reason, but also because he thinks this rapid repletion of the circulation is dangerous; that it causes the intestines to float in contact with raw surfaces; and that it pushes the diaphragm up, causing dyspnœa and pneumonia.

Gases.—Bainbridge[85] has recently advocated distending the abdomen with oxygen gas just prior to complete closure of the peritoneum, as a useful resuscitating and anti-adhesion measure. Cleveland [86] suggests the employment of oxygen to inflate the intestines in order to prevent and relieve acute post-operative obstruction, with distention, vomiting, rapid pulse, and respiration. Quite recently also Gellhorn [87] has recommended with considerable enthusiasm the periodic induction of intra-abdominal hyperæmia by means of the local application of the hot-air bath to the lower trunk. Strumpel [88] reported last year quite a large series of major abdominal operations and hernias in which this measure was employed. It was applied for one and one-half hours, at three-hour intervals, during the first forty-eight hours, if necessary. He warmly recommends it as a part of the routine post-operative therapy, claiming that it stimulates early peristalsis, with the passage of flatus and fæces; that it improves the patient's condition; that it is a prophylactic measure against peritonitis and adhesions; and that where the former exists it aids in its cure and localization.

Eschar of the Thermocautery.—As already pointed out, if this measure is utilized, the cauterization should be very thorough, so as to produce a deep and lasting charring of the tissues. It undoubtedly possesses distinct advantages under certain conditions.

Lubricants.—Because of their harmlessness, ease of application, and apparent effectiveness in many cases, various oily and fatty substances are perhaps more extensively used than any other single artificial measure in the treatment of adhesions. A number of substances of this kind have been suggested from time to time and carefully studied experimentally. Morris [68] testifies that he saw Martin, of Berlin, in the eighties rubbing oil on raw peritoneal surfaces. He is generally accredited with being the first to employ this measure, although I have been unable to find any publication from him on the subject. Vogel [23] obtained some success in rabbits with a mucilage of gum arabic. Busch and Bibergeil [75] tested a number of substances—including lanolin, paraffin, olive oil, and agar—all of which irritated the peritoneum and favored adhesions; while gum arabic and gelatin were too rapidly absorbed to be of value. Blake [89] concludes from a small number of experiments on cats that moderate quantities of olive oil (1–4 oz.) are not dangerous in the peritoneal cavities of animals; that it remains there 5–15 days; and that it tends to prevent adhesions to denuded or inflamed surfaces, but is not always effective. Gellhorn [87] experimented on dogs and rabbits, using liquid lanolin, but obtained only partial success. Claypool, Vance, Robertson, and Field [90] tested olive oil and liquid petrolatum on dogs. They concluded that the former tends to prevent adhesions, but that the latter is of little value. They found olive oil in the peritoneal cavity uniformly after three weeks in sufficient quantity to measure; sometimes also at the end of four weeks. They recommend sterilizing the olive oil at 115° C. for 15 minutes, which they think does not split off fatty acids that irritate the peritoneum. Wilkie [91] also calls attention to the fact that the irritation of olive and other oils is due to the separation of fatty acids in the process of sterilization. He recommends vaseline oil—a liquid paraffin which comes to the surface in the preparation of vaseline—as being absolutely neutral and unchanged by sterilization. He strongly advocates its use in mopping over denuded surfaces in the peritoneal cavity. This class of substances seems undoubtedly to possess some merit as prophylactic agents against adhesions; and it is very probable that the presence of fatty acids set free during sterilization is responsible for some of the conflicting results obtained. I have had opportunity, however, to observe the ultimate effect of both olive and vaseline oils in one case of very extensive peritoneal adhesions. After the adhesions were released, I carefully applied sterile olive oil to all of the denuded surfaces before closing the abdomen. At a subsequent laparotomy for pernicious vomiting, about a year later, the adhesions were fully as wide-spread and dense as at the other operation. This time I substituted vaseline oil, which was applied with great care and thoroughness; but again within a year laparotomy became necessary, and there was no evidence whatever of benefit from the lubricant. I am indebted to Dr. H. A. Kelly for the privilege of mentioning this case, which was seen in his department at the Johns Hopkins Hospital.

Non-viable Animal Membranes.—The so-called Cargile membrane, made from the peritoneum of the ox, a similar membrane made from the shark's peritoneum, goldbeaters skin, derived from the outer coats of the cæcum of the ox, and a finely woven cloth made of catgut constitute the members of this group. Cargile membrane has been more extensively used than any of these, due largely to the enthusiastic advocation of it by Morris.[92] He obtained the idea from Dr. Chas. H. Cargile, of Bentonville, Ark., and hence gave the membrane his name. Morris concluded from a small number of experiments on rabbits that the membrane resists absorption in the peritoneal cavity more than 10 and less than 30 days; that it causes temporary loose adhesions of a harmless kind, which are mostly absorbed in less than 30 days; that it causes very little disturbance, is not a good culture medium, protects raw surfaces until repair occurs, and remains in position without stay-sutures, if kept dry. In a later publication he admits failure with the membrane in some cases. He suggested substituting shark's peritoneum, because it is cheap and plentiful. Baum[93] justly claims priority in the discovery of the so-called Cargile membrane. In 1894 he published a brief report of experiments with catgut woven into cloth, fish-bladder, and peritoneum prepared from young calves freshly slaughtered. His results were encouraging, and he warmly recommended these substances for general use. Craig and Ellis[94] subjected the Baum (Cargile) membrane to a careful experimental and histological study. They showed that in the peritoneal cavity, both the chromicized and unchromicized varieties are of no value in preventing adhesions, but that, on the contrary, they act as foreign bodies, and promote adhesion formation. Stavely[95] reports a case laparotomized six times for adhesions, three of which operations he performed. He employed this membrane, but found at a subsequent laparotomy that it had failed. Lauenstein[96] used a silk protective to prevent adhesions about the gall-bladder in one case, but found it of no practical value. Theoretically, it is surprising that these membranes do not uniformly provoke rather than prevent adhesions—and, as shown by the above citations, there is considerable evidence in support of this view—inasmuch as a piece of dead animal tissue that has been kept in preservative fluid, although it may later undergo absorption, is nothing more nor less than a true foreign body while it remains in the peritoneal cavity, and must be so regarded in its relations to adhesion formation. It seems to me inevitable, therefore, that these substances will gradually fall into disuse.

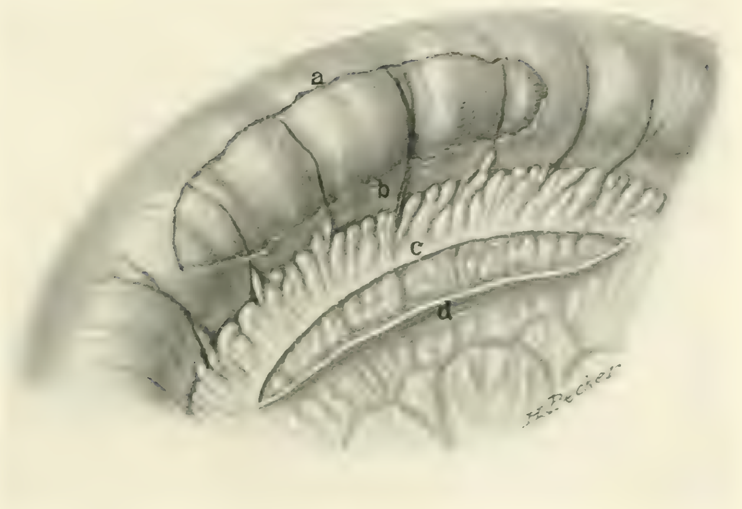
Viable Grafts.—Much more rational are the efforts to cover raw surfaces by plastic operations on the peritoneum, or with peritoneal or omental grafts, as will appear from the following reports. Senn[99] demonstrated experimentally, in 1888, that omental grafts 1–2 inches wide, and long enough to completely encircle the bowel, retain their vitality, become firmly adherent in 12–18 hours, and freely supplied with blood-vessels in 18–48 hours. Also that both the adhesions and the vascularization are hastened and improved by preliminary scarification of the serous surface and the graft. He recommended the use of such grafts in wounds of the gastro-intestinal canal, to reinforce circular enterorrhaphy, and to cover up peritoneal defects and pedicle stumps. V. Dembowski[59] the same year reported experiments which showed that if the omentum be sutured to the anterior abdominal wall, it becomes firmly adherent in 3–4 days, but that the intestine never adheres to it. Tietze[98] reported successful reinforcement experimentally of stomach and intestinal sutures by the application of parts of the attached omentum. His cases included three groups: (1) reinforcing experimentally produced necrotic areas in the stomach and intestinal walls; (2) reinforcing end-to-end intestinal anastomosis; (3) closure of stomach defects with plugs of omentum. Thompson[58] concluded that if the omentum be simply spread out behind the abdominal wound, it prevents the intestines becoming adherent to the latter. Webster[44] recommends, among other measures, covering raw surfaces with adjacent healthy peritoneum, and also transplanting grafts of both peritoneum and omentum. Amann[99] advocates covering defects in the pelvis with movable peritoneal flaps, such as can be obtained from the anterior half of the pelvis. He also recommends mobilizing the sigmoid and suturing it to the uterus, or, if the latter is removed, to the bladder peritoneum, or to that of the pelvic brim, to prevent the small bowel falling into the pelvis and becoming adherent. Morris[92] also employs the Senn omental graft. Loewy,[100] on the basis of his experimental work, recommends the employment of omental grafts in a number of conditions, and discusses several types that he has successfully used. Girgolaff[101] recently carried out an interesting series of experiments on omental grafts in cats and dogs, successfully covering raw surfaces of the large bowel, bladder, and stomach, without adhesions to the graft and without failure of the latter. On the small bowel, however, the graft adhered either to adjacent loops of small bowel or to other structures. He injected the thoracic aorta 18–24–48 hours, and 3–5–7 and more days after the grafting with coloring matter, and even where the graft had formed no adhesions, except to the organ applied, he succeeded in thus injecting its capillaries in the surprisingly short period of 24 hours, and to a greater extent later on. Springer[102] published last year the results of a careful experimental study of omental grafts in dogs. He found that if the entire free omentum be amputated and simply dropped into the abdomen, it does not necrose but becomes spread out, adheres to the parietal peritoneum, and becomes quickly vascularized. Further, that detached omental flaps sewed over considerable areas of the small bowel adhere, are rapidly vascularized, and are useful for covering raw surfaces without causing any narrowing of the lumen. But that such flaps always adhere extensively to neighboring loops of bowel; they do not compensate defects, but reinforce; they do not prevent adhesions, except on movable organs with strong peristalsis, like the stomach and urinary bladder; that they are good for reinforcing lateral and end-to-end anastomoses of hollow viscera; that omental stumps also become adherent unless covered in, and that omental grafts may be used to cover peritoneal defects.

It is very evident, therefore, that grafts of fresh omentum and peritoneum have a very important and wide field of application in abdominal surgery, and that they constitute one of our most valuable prophylactic and controlling methods in dealing with adhesions. Autoplastic grafts are to be preferred, of course, but I am of the opinion that, with the exercise of proper precautions, homoplastic grafts might also often be advantageously used, at least in our larger clinics where abundant material is available. But the supply to be obtained even here would prove entirely insufficient for use in a case of generalized or universal peritoneal adhesions. These are the cases that baffle us, and that stubbornly resist any or all of the methods of treatment thus far suggested. I have already indicated the futility of repeatedly releasing these adhesions indiscriminately and in whatever direction seems to be easiest at the time of the operation, thus blindly dissecting without definite aim until the patient's collapse forbids our going further; and I pointed out, on the other hand, the wisdom of studying these cases more closely beforehand to determine clinically which area of adhesions are specifically responsible for the patient's symptoms. In the solution of this problem we will be greatly aided by bearing in mind especially those parts of the gastro-intestinal canal which are known to cause trouble when they become involved in adhesions and kinked. In the majority of instances one or more of these regions will be found to be our vantage point in the operative attack, and our effort should be to restore as near to normal as possible these parts. The method of procedure, then, is first of all an accurate diagnosis; next release the adhesions that are causing the trouble; then partly prevent and partly restrict their re-formation to the harmless variety by the judicious application of viable grafts of omentum or peritoneum—preferably autoplastic or homoplastic ones, but if these are not obtainable, use heteroplastic grafts of peritoneum, obtained from a freshly slaughtered calf under aseptic conditions just prior to the operation, and carefully guarded from mechanical or chemical trauma—and by disposal and fixation, by suture if necessary, of the viscera according to normal anatomical relationship; so that whatever adhesions recur will aid in the accomplishment of our purpose. Such a course at least possesses the merits of being intelligent and feasible, and of saving the patient the added shock of a prolonged dissection through many square centimetres of viscerovisceral adhesions which are doing no harm, and which promptly re-form. These merits, to my mind, are sufficient to justify its adoption.

A NEW METHOD OF TREATING DENUDED BOWEL SURFACES.

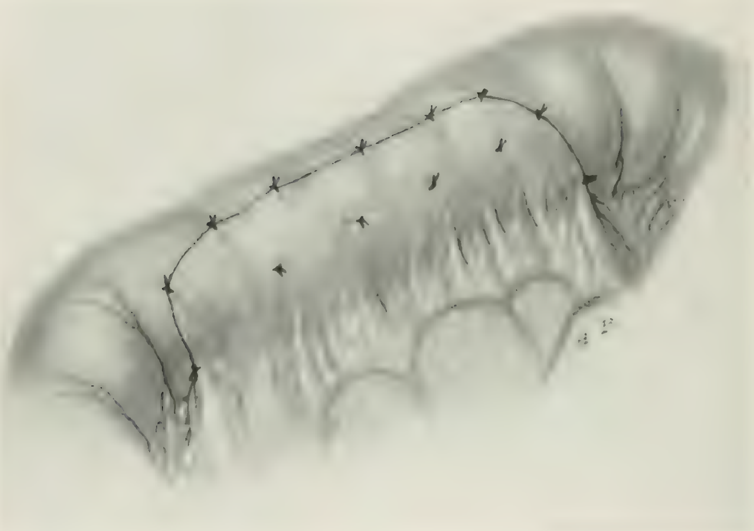
A few months ago, during the course of an operation for the relief of an enormous post-operative ventral hernia, a situation arose which suggested to me a new, and what I believed to be an eminently satisfactory, method of dealing with denuded bowel surfaces under certain conditions. The patient was a very large, fat woman, well past middle life, who by reason of circulatory and renal disease was rather a poor surgical risk. Moreover, about six months previously she had undergone a very serious operation for radical removal of the generative organs on account of a moderately advanced cancer of the uterine cervix, at which time the abdominal wound had evidently become infected and broken down, with a resulting hernia. Occupying the hernial sac, besides a bulky omentum densely adherent throughout, there was a long loop of ileum, coiled in a horse-shoe fashion, each limb of which had become so intimately adherent to the peritoneal lining of the sac as to render separation along any definite line of cleavage impossible. The two limbs were also adherent to each other by several transverse bands of dense fibrous tissue. After effecting the release of the intestine I had, therefore, two extensive raw areas, each measuring two to three inches in length, involving nearly one-half the circumference of the bowel, and separated from each other by six or eight inches of practically normal intestine.

FIG. 1.



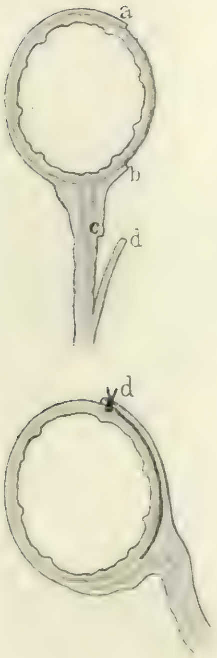
An extensive denuded area on the surface of the ileum is here shown. Observe that at its widest portion, *a–b*, it involves nearly half the circumference of the bowel. The liberal deposit of fat in the mesentery here represented admits of the ready separation of its two peritoneal leaves. Note that the incision for this purpose through the upper leaf is made about 1 cm. from its bowel attachment, in order to avoid the numerous branching vessels in this region. The separation of the flap *d* is now easily and safely effected to any desired extent, since the average width of the mesentery is eight inches. A flat, blunt instrument—a spatula, for example—is best suited for this step. The rich vascular anastomosis between the mesenteric leaves, afforded by the superimposed colonnade arrangement of the trunk vessels, is easily seen.

FIG. 2.



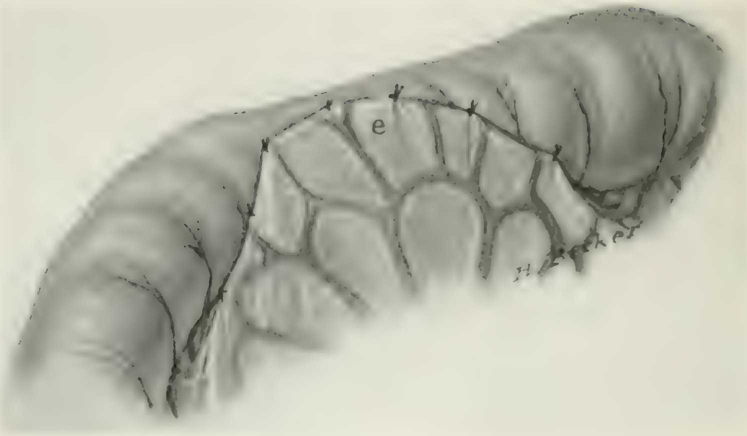
The detached flap of peritoneum is here shown drawn up over the raw bowel surface and firmly fixed by interrupted sutures of fine silk. Note how completely and satisfactorily the defect has been remedied. Observe too, that, owing to the mobility of both the bowel and its mesentery, the mechanical effect on the bowel lumen and the mesenteric circulation is negligible and cannot produce any serious consequences. Care must be taken to close the angles of the mesenteric flap just at the bowel margin as shown, to avoid the possibility of an intramesenteric hernia.

FIG. 3.



The bowel and its mesentery are here represented in cross-section. In the upper drawing the area between *a* and *b* [illegible] one peritoneal leaf of the mesentery; and *d* the flap to be freed and drawn up. The lower drawing shows the flap *d* closely applied over the denuded area, and fixed by sutures which should penetrate the submucosa.

Fig. 4.



The plication modification of the method is here shown. Owing to an almost total absence of fat between the peritoneal leaves of the mesentery in some cases, it is unsafe and impracticable to attempt their separation. In such cases *neither leaf is incised or separated from its bowel attachment*, but both leaves are grasped together at the proper distance from the bowel border, lifted over the raw surface, and fixed by silk sutures. It amounts to a plication of the mesentery or a partial envelopment of the bowel within both layers of its mesentery. Note that care has been taken to place the sutures between the vascular trunks. This simple modification renders the method applicable to all cases, is even more quickly executed, and is eminently safe and satisfactory.

Another factor of great surgical importance was the extensive dissection necessary to cure the hernia, by reason of the wide separation of the recti muscles, the enormous size of the opening, the abundant scar tissue produced by the old infection, and the atrophy and impaired vascularity of the tissues to be utilized in effecting the closure. These unfortunate circumstances, together with the patient's general condition, made it highly important that all possibility of wound infection should be scrupulously avoided, as well as that every possible precaution should be taken against the occurrence of intestinal obstruction, which might necessitate the undoing of all my work.

Now recalling the condition of the bowel surface just described, it is evident, upon consideration, that none of the customary methods of dealing with this complication were applicable to the conditions in hand. I could not, for example, invert the raw surfaces, because of their extent and proximity to each other—obstruction would almost certainly have ensued. The various other methods already described were either impracticable or too unreliable, in view of the serious consequences of failure. I did not dare resort to lateral anastomosis, because I was dealing with the lower ileum; and while this procedure would have taken care of the raw surfaces and obviated the danger of obstruction, it would at the same time have afforded an excellent opportunity for infection of the devitalized tissues of the wound, with complete destruction of all my plastic work and immediate recurrence of the hernia. Fortunately, the problem was practically solved for me by the accidental laceration and partial retraction of one leaflet of the mesenteric peritoneum just along the line of its attachment to the bowel, and adjacent to one of the raw areas on the surface of the latter, which occurred during its separation from the hernial sac (Fig. 1). There being a considerable deposit of fat between the two layers of mesenteric peritoneum, it was a surprisingly simple and easy procedure to extend the separation of the torn leaflet and its attached fat in all directions from the underlying vessels and the opposite intact leaflet with its fat, thus obtaining a large, movable flap of normal peritoneum, which was easily drawn up without tension, spread out over the raw surface on the bowel, and tacked down with a few fine silk sutures (Fig. 2). The result was eminently satisfactory in every way, this very simple device, which was quickly carried out, having sufficed to abolish a rather complex and embarrassing surgical situation. The patient's recovery was complete, and she is now comfortable and happy.

This fortunate experience led me to investigate the idea further, in order to determine accurately its possibilities and limitations, and to meet certain theoretical objections.

Thus it was desirable to ascertain if the method could be applied to all portions of the intestinal tract; if the separation of the two peritoneal leaves of the mesentery could be rapidly effected, without injury to the vessels, in poorly nourished individuals whose mesentery usually contains very little fat; and if not, to consider the feasibility of lifting a fold of both leaves of the mesentery, without incising either, over the raw surfaces, thus effecting practically a plication of the mesentery—a modification of the method that would make it applicable to these cases also (Fig. 4); to determine further, what effect this axial rotation or partial envelopment of the bowel within its own mesentery would have on the calibre and direction of the lumen, with reference to obstruction; to investigate to what extent it would be practicable to so treat the bowel; to ascertain particularly what effect was produced on the mesenteric and bowel circulation by this mechanical alteration of normal conditions; and finally, how much tension the leaflet of peritoneum is capable of withstanding, with reference to its being torn loose by post-operative distention or vigorous peristalsis.

The fresh cadaver seemed to offer the best method of settling these questions, and my conclusions, based upon such a study, are as follows:

1. The procedure is best applicable to that portion of the intestinal tract where, in such cases as the one described,

present methods are inadequate, namely, from the upper jejunum to the lower ileum. It may be rationally applied, however, to any portion of the bowel possessing a mesentery of sufficient length to admit of its ready execution.

2. Care must be exercised at the duodenum, upper jejunum, and lower ileum not to produce kinks of the bowel.

3. In cases exhibiting a scanty deposit of fat in the mesentery, plication is a rapid, safe, and efficient substitute for separation of the two peritoneal leaves.

4. Aside from a slight spiral rotation, which in view of peristalsis and the mobility of the parts is entirely insufficient to produce obstruction, the procedure has no demonstrable effect on the bowel lumen.

5. It can be safely extended to include nearly one-half the circumference of the bowel, and three to four inches in continuity. There is no apparent reason why it should not be repeated as often as necessary at different levels of the intestinal tract.

6. In view of the rich vascular anastomosis and the mobility of both the bowel and its mesentery, if care be exercised in placing the sutures so as to avoid the trunk vessels, the effect upon the circulation is negligible.

7. Stability and permanence of the coaptation is readily secured through intelligent disposition of the sutures.

SUMMARY.

Peritoneal adhesions are of two kinds, those which are useful, and those which are harmful and dangerous.

It is futile to search for some agent that will banish adhesions from the realm of abdominal surgery, inasmuch as the processes involved in their formation are identical with those involved in peritoneal repair.

In dealing with peritoneal adhesions, the surgeon has recourse to three classes of procedures: (1) measures which prevent their formation; (2) measures which restrict their formation to the harmless variety; (3) measures which aid in their absorption.

Certain anatomical and physiological characteristics of the peritoneum have an important bearing on the problem of peritoneal adhesions; notably its extensive area, its remarkable absorptive power and ability to successfully cope with infection, the variable sensibility of different portions, the continuity of its endothelial surface, the rapidity with which it can form adhesions, and the completeness with which it can later absorb them.

Injury or death of the highly vulnerable surface endothelium is sufficient to set in motion the chain of pathological events which may terminate in dense adhesions.

Etiologically, there are a number and variety of factors involved, but they can all be grouped under the two heads—sepsis and trauma.

As specific prophylactic and curative measures, emphasis should be given to: (1) rigid asepsis; (2) the use of moist hot gauze; (3) careful covering of all raw surfaces; (4) avoiding unnecessary exposure; (5) restricting trauma; (6) gastro-enterostomy and entero-enterostomy; (7) returning the viscera to their proper anatomical relationship; (8) spreading out the omentum over the visceral surfaces before closing the abdomen; (9) careful closure of the peritoneum. A number of additional safeguards are available which have been tested and proven to be of value under certain conditions. The most reliable of these for general use are: (1) viable grafts of omentum or peritoneum; (2) lubricants; (3) judicious ante- and post-operative therapy—especially with reference to posture, catharsis, enemata, and length of stay in bed.

The field of specific chemotherapy offers the brightest hope for future progress.

Success in the management of the more aggravated adhesion case depends largely upon accurate clinical diagnosis, followed by intelligent operative procedures, as pointed out.

In properly selected cases, the use of adjacent mesentery for covering raw bowel surfaces possesses distinct advantages over all methods hitherto proposed.

In conclusion, I desire to express my thanks to the Pathological Department of the Johns Hopkins Hospital for giving me the privilege of testing on the fresh cadaver the method above described.

REFERENCES.

[1] Starling and Tubby: Jour. of Physiol., 1894, xiv, 140.
[2] Mendel: Amer. Jour. of Physiol., 1898, ii, 16.
[3] Hamburger: Archiv. f. Physiol., 1895, 281.
[4] Orlow: Arch. f. d. ges. Physiol., 1894, lix, 170.
[5] Heidenhain: *Ibid.*, 1895, lxii, 320.
[6] Cohnstein: Centralbl. f. Physiol., 1895, ix, 401.
[7] Klapp: Mitteil a. d. Grenzgeb. d. Med. u. Chir., 1902, x, 254.
[8] Meltzer: Jour. of Physiol., 1897–8, xxii, 198.
[9] Adler and Meltzer: Jour. of Exp. Med., 1896, i, 482.
[10] MacCallum: Johns Hop. Hosp. Bull., 1903, xiv, 105.
[11] Kolossow: Arch. f. Mikroskop. Anat., 1893, xlii, 318.
[12] Muscatello: Virchow's Archiv., 1895, cxlii, 327.
[13] Lennander: Centralbl. f. Chir., 1901, xxviii, 209; Mitteil a. d. Grenzgeb. d. Med. u. Chir., 1902, x, 38; *Ibid.*, 1906, xv, 465; *Ibid.*, 1907, xvi, 19, 24; Tr. Amer. Med. Assoc., Sect. on Surg., 1907, 211.
[14] Cushing: Phila. Med. Jour., 1900, v, 501.
[15] Sampson: ANN. OF SURG., 1905, xli, 216.
[16] Broese: Zentralbl. f. Gyn., 1910, xxxiv, 1532.
[17] Mitchell: Jour. Amer. Med. Assoc., 1911, lvii, 709.
[18] Ramström: Inaug. Dissert., Wiesbaden, 1905; also Anat. Hefte, Wies., 1905, xxix.
[19] Wegner: Arch. f. klin. Chir., 1877, xx, 51.
[20] Graser: *Ibid.*, 1895, l, 887; Deutsch. Zeitschr. f. Chir., 1887–8, xxvii, 533.
[21] Hertzler: Tr. Western Surg. and Gyn. Assoc., Dec., 1904.
[22] Pentzoldt: Deutsch. Arch. f. klin. Med., 1876, xviii, 542.
[23] Vogel: Deutsch. Zeitschr. f. Chir., 1902, lxiii, 296.
[24] v. Dembowski: Arch. f. klin. Chir., 1888, xxxvii, 745.
[25] Gersuny: *Ibid.*, 1899, lix, 102.
[26] Zweifel: Münch. med. Wochenschr., 1903, l, 1449.
[27] Füth: Zentralbl. f. Gyn., 1905, xxxix, 1313.
[28] Fromme: Zeitschr. f. Geburtsh. u. Gyn., 1907, lix, 313.
[29] Flateau: Münch. med. Wochenschr., 1904, li, 42.
[30] Baisch: Beiträge z. Geburtsh. u. Gyn., 1905, ix, 437.
[31] Hallwachs: Arch. f. klin. Chir., 1879, xxiv, 122.
[32] Spiegelberger and Waldeyer: Virchow's Archiv., 1868, xliv, 69.
[33] Rosenberger: Arch. f. klin. Chir., 1880, xxv, 771.
[34] Tillmanns: Virchow's Archiv., 1879, lxxviii, 437.
[35] ten Brink: Zeitschr. f. Geburtsh. u. Gyn., 1898, xxxviii, 276.
[36] Kelterborn: Centralbl. f. Gyn., 1890, xiv, 913.

[37] Stimson: Trans. Amer. Surg. Assoc., 1889, vii, 65.
[38] Klotz: Centralbl. f. Gyn., 1892, xvi, 977.
[39] Rubin: Surg. Gyn. and Obstet., 1911, xii, 117.
[40] Neuhof and Wiener: *Ibid.*, 1910, x, 348.
[41] Franz: Zeitschr. f. Geburtsh. u. Gyn., 1902, xlvii, 64.
[42] Maslowsky: Arch. f. klin. Chir., 1868, ix, 527.
[43] Küstner: Centralbl. f. Gyn., 1890, xiv, 425.
[44] Webster: Chicago Med. Recorder, 1901, xxi, 394.
[45] Walthard: Cor. Bl. f. Schweiz. Aertze, 1893, xxiii, 513.
[46] Schiffer: Zentralbl. f. Gyn., 1894, xviii, 913.
[47] Uhlmann: Arch. f. Gyn., 1897, liv, 384.
[48] Fritsch: Centralbl. f. Gyn., 1890, xiv, 515.
[49] Martin: Zeitschr. f. Geburtsh. u. Gyn., 1888, xv, 239.
[50] v. Velits: Zeitschr. f. Geburtsh. u. Gyn., 1890, xx, 384.
[51] Koblanck: *Ibid.*, 1898, xxxviii, 147.
[52] Huth: Inaug. Dissert., Berlin, 1904.
[53] Pernhorst: Inaug. Dissert., Kiel, 1901.
[54] Steffens: Beiträg. z. klin. Chir., 1899, xxiii, 302.
[55] Reichel: Deutsch. Zeitschr. f. Chir., 1893, xxxv, 495.
[56] V. Braun-Fernwald: Sitz. d. Geburtsh.-Gyn. Gesellsh., Wien, Nov. 16, 1897.
[57] Jesset: Jour. Obstet. and Gyn. Brit. Emp., 1903.
[58] Thompson: Zentralbl. f. Gyn., 1891, xv, 105.
[59] V. Dembowski: Zentralbl. f. Gyn., 1876, xx, 51.
[60] Delbet, Grandmaison and Bresset: Ann. de Gynéc. et d'Obstet., 1891, xxiv, 22.
[61] Tinker: Amer. Med., 1907, N. S., ii, 284.
[62] Pankow: Quoted by Fromme (28).
[63] Sänger: Arch. f. Gyn., 1884, xxiv, 1.
[64] Rissmann: Berl. klin. Wchnschr., 1896, xxxiii, 650.
[65] Ward: Amer. Jour. Obstet., 1901, xliii, 753.
[66] Stern: Beiträg. z. klin. Chir., 1889, iv, 653.
[67] Wright: Lancet, 1904, ii, 73.
[68] Morris: Amer. Jour. Obstet., 1906, liv, 764.
[69] Ellis: Amer. Med., 1906, N. S., i, 481.
[70] Clark: Surg. Gyn. and Obstet., 1909, ix, 603.
[71] Cumston: Amer. Jour. Obstet., 1906, liii, 381.
[72] Byford: Surg., Gyn. and Obstet., 1909, viii, 576.
[73] Paton: Med. Press and Circ., 1907, N. S., lxxxiv, 30.
[74] V. Hippel: Centralbl. f. Chir., 1907, xxxiv, 1345.
[75] Busch and Bibergeil: Arch. f. klin. Chir., 1908, lxxxvii, 99.
[76] Uyeno: Beiträg. z. klin. Chir., 1909, lxv, 277.
[77] Eastman: Indiana Med. Jour., 1905–6, xxiv, 299.
[78] Offergeld: Münch. med. Wchnschr., 1905, lii, 1769, 1828.
[79] Michael: Berl. klin. Wchnschr., 1907, xliv, 1606.
[80] Sidorenko: Deutsch. Zeitschr. f. Chir., 1911, cx, 89.
[81] Marvel: Jour. Amer. Med. Assoc., 1907, xlix, 986.
[82] Müller: Arch. f. Gyn., 1886, xxviii, 448.

[83] Malcolm: Lancet, 1890, i, 75.
[84] Cumston: *Loc. cit.* (71).
[85] Bainbridge: Ann. of Surg., 1909, xlix, 305.
[86] Cleveland: Med. Rec., 1901, lix, 1.
[87] Gellhorn: Amer. Jour. Obstet., 1909, lix, 1030; Tr. Amer. Gyn. Soc., 1909, xxxiv, 515; Surg., Gyn. and Obstet., 1909, viii, 508.
[88] Strumpel: Deutsch. Zeitschr. f. Chir., 1910, cv, 527.
[89] Blake: Surg., Gyn. and Obstet., 1908, vi, 667.
[90] Claypool, Vance, Robertson, and Field: Jour. Amer. Med. Assoc., 1910, lv, 312.
[91] Wilkie: Surg., Gyn. and Obstet., 1910, x, 126.
[92] Morris: Med. Rec., 1902, lxi, 773.
[93] Baum: Jour. Amer. Med. Assoc., 1894, xxiii, 242; Med. Rec., 1902, lxii, 183.
[94] Craig and Ellis: Ann. of Surg., 1905, xli, 801.
[95] Stavely: Wash. Med. Ann., 1910, ix, 1.
[96] Lauenstein: Arch. f. klin. Chir., 1893, xlv, 121.
[97] Senn: Ann. of Surg., 1888, vii, 1, 99, 171, 264, 367, 421.
[98] Tietze: Beiträg. z. klin. Chir., 1899, xxv, 411.
[99] Amann: Cong. Internat. de Med. Comp. rend. Sect. de Gyn., 1900, 435.
[100] Loewy: Compt. rend. Soc. de Biol., Paris, 1900, iis, ii, 91; Rev. de Gyn. et de Chir. Abdom., 1906, x, 821.
[101] Girgolaff: Zentralbl. f. Chir., 1906, xxxiii, 1212.
[102] Springer: Beiträg. z. klin. Chir., 1910, lxvii, 17.

CONSIDERATIONS RELATING TO THE PATHOGENESIS AND DIAGNOSIS OF SURGICAL DISEASES OF THE PANCREAS.*

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THE intimate relation each disease met with in the upper abdomen bears to the other, especially from the viewpoint of cause and effect, makes it well nigh impossible to separate either from the other without omitting much valuable information common to them all; indeed, it was through a search into the complications of bile-duct disease, especially calculi, that our present knowledge of pancreatitis was acquired.

Embryology.—The subject must therefore involve a consideration of not only the existence of the three major organs, the liver and its ducts, pancreas, and duodenum, but the surgeon must have, as well, a working knowledge of their embryology, anatomy, and physiology, in order that he may properly understand the important relation the organic internal secretions bear to digestion and assimilation; for it is now generally accepted as proven that the control of this function by the internal secretions takes precedence during embryologic evolution over the nervous system, and retains a large measure of that responsibility even after the central nervous system is developed. The duodenum, in this anatomic trio, is the trunk, with the bile and pancreatic ducts its branches. The intimate anatomic relation of the stomach, duodenum, liver and pancreas, through the close association of the main ducts of the two latter and the viscera, must always be borne in mind in undertaking differential diagnosis. For example, the pancreas, which is an organ of both external and internal secretions, has its internal secretion intimately associated with the glands of Brunner, situated in the duodenum, while its external secretion is even more closely associated with that of the bile.

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* Read before the West Branch of the Philadelphia County Medical Society, Oct. 17, 1911.

Anatomy.—The protected position of the pancreas emphasizes its importance. The head lies closely embraced by the duodenum just beneath the pylorus, its body behind the stomach covering the great vessels, while its tail reaches over to the spleen and left kidney. The embryologic development of the pancreas, as two separate outgrowths from the primary foregut to afterward coalesce, is important to keep in mind, as it often retains two separate ducts, Wirsung and Santorini. The latter is the direct duct, yet in 20 per cent. of cases it undergoes complete obliteration, while in the remaining 80 per cent. it anastomoses with the indirect or duct of Wirsung, and empties by a separate orifice into the duodenum. In one individual out of ten the duct of Santorini is even of larger calibre than the duct of Wirsung. In such cases as this, the pancreatic secretion will be emptied into the duodenum even when the Wirsung duct is occluded.

The common bile-duct in conjunction with the duct of Wirsung enters the under surface of the second portion of the duodenum through a vestibule, the ampulla of Vater, where the secretions from the two glands are mixed before they take their respective places in the digestive process.

The anatomic relation of the main duct of the pancreas and that of the liver has its physiologic significance in showing the importance of associating bile in the process of digestion. From a pathologic standpoint, this association is most unfortunate, for it is the factor in causing many of the morbid processes to which both the pancreas and biliary passages are subject. In two-thirds of all cases the bile-duct passes directly through the head of the pancreas on its way to the duodenum. This fact, together with the close vascular and lymphatic association between the bile passages and pancreas, furnishes the pathogenesis of the greater number of the cases of pancreatitis. It is obvious that infection of one of these organs must be easily transmitted to the other, though this, of course, does not exclude such constitutional dyscrasias as mumps, typhoid fever, phthisis, syphilis, and arteriosclerosis having a large responsibility in bile-duct and pancreatic disease. Pressure of the swollen head of the pancreas on the common bile-duct is a causative factor in epidemic jaundice, second only in frequency to cholelithiasis and duodenitis, though mumps, according to collective investigation of Egdel, is responsible for 10 per cent. of all cases of pancreatitis.

Of greatest interest is the association of cholelithiasis with chronic interstitial pancreatitis, the so-called interlobular form. This is due to duct obstruction from gall-stones, with infection always present, though fortunately usually mild. The interacinar form of pancreatitis is less commonly met with and differs from the rough and nodular interlobular variety in being smooth and tough with glycosuria usually present in the latter on account of involvement of the islands of Langerhans, though in the interlobular variety these areas may also become involved, causing secondary diabetes. It is generally admitted that chronic interstitial pancreatitis may exist for years without appreciable change from the original disease, though during this period the proteolytic, the lipolytic, and diastatic properties of both its external and internal secretions will be noted in the characteristic findings in the intestinal excreta and the defect in its metabolic function of converting both sugars and fats.

This chronic process will not only cause disease of contiguous organs or viscera, but will, and generally does, extend to remote ones through faulty metabolism.

Symptoms.—Symptoms that arise from pressure on the common bile-duct, due to the swollen head of the pancreas, cannot be differentiated with accuracy from those due to cholelithiasis. Both conditions cause jaundice, though that caused by pancreatitis is more apt to be permanent, with associated cutaneous pigmentation and a rapid effect on the constitution evidenced by a profound and progressive emaciation, the result of pancreatic insufficiency (achylia pancreatica). While in bile-duct obstruction uncomplicated by pancreatic disease, pain and jaundice exist during the acute attack of colic only or during the temporary passage of calculus through the common bile-duct and when cholelithiasis and pancreatitis coexist, there is a distinct point of tenderness upon pressure, half way between the ninth rib and the umbilicus, and a second area of tenderness over the right rectus abdominis muscle, above and to the right of the umbilicus.

If duodenal ulcer can be excluded, these symptoms would justify diagnosis of pancreatitis. Reflex pain radiating to the midscapular or left scapular region, together with absence of emaciation and the presence of hyperchlorhydria and pain when the stomach is empty, will exclude duodenal ulcer. In pancreatitis it is generally possible to detect an enlarged, hardened, and tender pancreas, extending across the upper abdomen, and a careful study of the alimentary excreta will reveal large light-colored, grassy stools, which are not found in duodenal ulcer. But most important is the discovery of nucleated muscular fibres in the stools, as the presence of these is distinctly a feature of pancreatic insufficiency, and occurs in pancreatitis only; as a further laboratory effort toward establishing a diagnosis the urine should be examined for Cammidge crystals. Emaciation is at times so rapid as to suggest malignancy.

Acute Pancreatitis.—The pancreas has been aptly described as the salivary gland of the abdomen, and, were it not for its association with the main duct of the liver, it would probably seldom be the seat of acute inflammation, the symptoms of which are sudden onset of agonizing pain, deep-seated and referred to the right of the epigastrium and followed by great prostration, rapid pulse, early elevation of temperature, nausea, vomiting and early tympanites accompanied by (according to Opie, Ochsner, and Halstead) marked cyanosis, especially about the face and abdominal walls. With this group of symptoms, as they are the most classic, it is difficult to make a diagnosis, because the upper abdominal muscles are extremely tense and the abdomen generally tympanitic, so that this group of symptoms does not differ materially from those arising from such acute conditions as intestinal obstruction, perforation of the hollow viscera, renal colic, or ectopic gestation.

Sugar may be present in the urine, in some cases, where chronic pancreatitis has existed for a considerable period, free fat (according to Fitz) may be seen in the fæces upon inspection, and occasionally a tender, tumorous mass can be felt. It is fortunately a condition where accuracy of diagnosis is not essential, since the simulating conditions all require surgical intervention.

The patient is usually at or about middle life, fleshy, and with an alcoholic history, and he rapidly develops a bronzed appearance (hæmatogenous jaundice). This pigmentation is characterized by uniformity and absence of mucous membrane discoloration. From the onset of the attack these patients are in a state of collapse, and therefore not promising subjects for operative treatment, yet immediate operation offers the only possibility of cure. Robson, by this means, had 23 recoveries out of 59 operated.

The operative procedure consists in a median abdominal incision above the umbilicus, which will disclose an excessive amount of blood-stained peritoneal fluid, usually stones in the gall-bladder and common duct, while the pancreas will show hemorrhagic infiltration and numerous areas of fat necrosis, recognizable as yellow spots, while the swollen organ itself will give on palpation a semi-fluctuating feel.

The treatment, which is surgical from the onset because of the profound toxæmia that actually ushers in the attack, should consist of promptly establishing free drainage through incisions made in several parts of the gland. If excessive hemorrhage ensues, it can be controlled by gauze packing held in place by sutures. The final step must be to establish free drainage through the abdominal incision anteriorly by means of either perforated rubber or glass tubes thoroughly protected by gauze pack. Posterior drainage, which is advocated by some, cannot be so effectual as the anterior route, because the head of the pancreas, which is the seat of greatest infection, lies in front of the vertebræ and is therefore not directly accessible from that point.

If stones are present in the gall-bladder or bile-ducts, or there is acute infection of the bile-ducts with jaundice, it is necessary in addition to free the gall-bladder and ducts of accumulated calculi, and establish drainage by a right lateral incision through the anterior abdominal wall, provided the patient's condition will permit.

Subacute Pancreatitis.—There is a certain number of acute cases where, because of either a lessened amount of viruleney or an impairment in the activity of the infective products, the severity of the symptoms as noted in the acute form of the disease are less marked, and a more favorable outlook from the onset is to be expected. The patient has passed through the height of infection, and thereby built up a resistance that offers to surgery a better prognosis.

When the abdomen of such a case is opened, there are found scattered through the omentum, mesentery, and fatty tissues areas of fat necrosis, which have resulted from the escape of the fat-splitting ferments of the pancreas with here and there multiple foci of purulent material.

Treatment.—Treatment consists in evacuating the abscesses and draining. Calculi in the gall-bladder and the bile-ducts should be removed and free drainage instituted. Search must also be made for hæmatoma, which may be found either in the pancreas or adjacent tissues, the result of pancreatic apoplexy.

Chronic Pancreatitis.—Chronic interstitial pancreatitis is usually characterized by an antecedent history of indigestion with mild gall-stone attacks. The fact that two-thirds of all common bile-ducts pass through the head of the pancreas is sufficient to emphasize the certainty that, in at least two-thirds of the cases of chronic pancreatitis, drainage through this duct must be interfered with, making jaundice a conspicuous objective symptom, though in a certain number of cases this symptom may be absent and yet the common bile-duct may be distended. This fact shows that dilatation of the common duct may exist independent of gall-stones, and both the duct and the gall-bladder may be distended without jaundice.

Courvoiser estimates that because of gall-stone irritation

84 per cent. of the cases of common duct stones have atrophic gall-bladder. Therefore, the size of the gall-bladder in chronic interstitial pancreatitis depends upon whether gall-stones are or have been present.

Pancreatitis may cause such marked distention of the gall-bladder and primary jaundice without calculi being present, that malignancy may be suggested. When, however, the latter is the cause of the obstruction, the glands in the fissure of the liver become early involved, and the pressure arising therefrom so interferes with portal circulation that ascites early develops.

The intestinal excretion is large in quantity and greasy. Microscopically examined it will show nucleated muscle fibre and fat. If jaundice is absent the stools will be a bright yellow color, due to an absence of the pancreatic juices. These patients abhor meats and fats.

Treatment.—The treatment of chronic interstitial pancreatitis is equally surgical from the onset, though, because of milder degree of infection, radical treatment can, in some instances, be delayed to give medical treatment a chance. The latter, however, should not be persevered in until it has been proven useless, for if thus delayed, surgery may not be given its full opportunity.

The underlying principle of the surgical treatment is to establish either temporary or permanent isolation of the pancreatic and bile-ducts, so that infection from either can as nearly as possible be removed from the other. In undertaking to clear the ducts of the partly obstructing calculi, it is important for us to bear in mind that some of them may be concealed under the enlarged head of the pancreas, or small ones may be lodged in the hepatic ducts, above the primary division. This can always be avoided by careful palpation. After the removal of all stones and the freeing of the bile-ducts and pancreas from adhesions, a large flexible probe should be passed through the common duct into the duodenum. This, together with external gall-bladder drainage, will usually not only establish but maintain free drainage and prevent recurrence of infection.

Cholecystostomy, in my experience, is sufficient to cure the majority of these subjects, and is therefore the procedure of election, as it enables one to remove calculi and establish temporary external drainage more satisfactorily than any other operative procedure that I have generally employed. In cases, however, where it is essential to promptly supply the bile to the intestines for aiding digestion, cholecystenterostomy is the operation of choice. If there is total obstruction of the common duct from pressure of the head of the pancreas, then cholecystduodenostomy or cholecystojejunostomy will be required to overcome the obstruction.

The surgical treatment of chronic interstitial pancreatitis, unless calculi are present, is directed toward the biliary tract rather than the pancreas, and is best accomplished by diverting the bile to the surface or to a new place in the gastro-intestinal canal, by some of the several operative procedures now so generally employed. Cholecystostomy is indicated in by far the greatest number of cases. The methods of employing the stomach and the hepatic flexure of the colon for the purpose of diverting the bile have not, as yet, taken precedence over those above referred to, and which are more generally employed.

GASTRIC AND DUODENAL ULCER.*

A RECORD OF 110 RECENT OPERATIONS.

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SINCE my first deliberate operation for the relief of symptoms due to chronic gastric ulcer, in March, 1900, a very large number of these cases have come under my care. It may, I think, prove interesting and instructive if I very briefly place on record some lessons to be learned from a study of these cases. In doing so, I do not propose to waste time by any recapitulation of well-established facts, but to see how far we can throw any fresh light on what is one of the very commonest ailments which we are called upon to treat.

For the purposes of this paper, I have collected all my cases since September, 1908. The list shows 110 cases, with three deaths, all of which occurred in my private practice—one from pneumonia, one from plastic peritonitis, one from wound infection caused by the patient herself.

This represents a mortality of 2.7 per cent. With greater care in the selection of cases and improved technic, I have no doubt still better results can be obtained.

My cases were in no way selected. Several of them were so wasted and feeble that it seemed very doubtful whether they could stand a general anæsthetic. No case was refused except on the ground that a thoroughly efficient course of medical treatment had not been submitted to. In several instances the operation was a very complicated and difficult one.

Two patients were over sixty years of age.

When we consider the debilitated and unhealthy condition of a large number of sufferers from long-standing gastric ulcer, I am afraid we must always be prepared to face an appreciable risk. It is never right to underestimate the gravity of any operation, but I am satisfied that we may quite safely put the risk in an average case as not higher than 2 per cent.

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*Read before the Ulster Medical Society, March 2, 1911.

There can be no doubt whatever that this is decidedly less than the ordinary medical risk. The risk of perforation alone cannot possibly be put below 5 per cent., and is probably much higher. The risk of hemorrhage is difficult to estimate, there being no reliable statistics, but experience teaches every medical man that this is not an uncommon cause of death.

During the past three years I have known one patient die from hemorrhage, and two from perforation, while considering the question of operation. Several of the cases operated on by me were on the verge of perforation, all the coats of the stomach having been eaten away except the peritoneum, which fortunately was strengthened by adherent omentum or plastic lymph, nature having done all in her power to avert a calamity.

The medical risk is, however, a somewhat vague and indefinite one which may never materialize; and which it is fair to point out, may not terminate fatally if promptly and skilfully treated.

The operation risk is one which is deliberately faced, and this requires some degree of courage on the part of the medical attendant who recommends it, and still more in the patient who submits to it.

In this connection I would like to point out the exceptional mortality attending perforation occurring in the victim of a dilated stomach.

In January, 1911, a railway porter consulted me. He had a greatly dilated stomach, and was very weak and exhausted. He went into hospital on a Saturday afternoon with a view to operation on the following Tuesday. At 11 o'clock on Saturday night he suddenly perforated. In my absence from town Mr. Fullerton very kindly operated on him within three hours after perforation. He never rallied.

however, from the initial shock, and died on Sunday forenoon.

In 1900 I saw with Dr. Calwell in the hospital a man with a greatly dilated stomach. We both strongly urged an operation, which was declined. He went to the convalescent home where he perforated and died in a few hours.

These cases are very liable to perforate, and when this accident happens, the peritoneum is simply drenched with stomach contents, often in an advanced condition of decomposition. The result is a profound toxæmia, almost certain to terminate fatally.

The study of a series of cases such as I now submit, in which the condition of the stomach has been actually inspected during life, should, I think, help us to appreciate, at their proper value, the individual signs and symptoms on which we are accustomed to rely for a diagnosis of gastric or duodenal ulcer.

These symptoms—pain, vomiting, hemorrhage, local tenderness, and local hyperæsthesia—and the evidence furnished by examination of the stomach contents, I now propose to consider very briefly.

Pain is the only symptom common to all cases, and though an ulcer may be present either in the stomach or duodenum, and may even perforate all coats of the organ before the onset of pain, I am satisfied that no physician would feel justified in coming to a diagnosis of ulcer in the absence of this cardinal symptom.

To be of any real value, the pain must have a definite relation to food. The patient must be quite clear as to the effect of a meal, and of different kinds of food.

Pain coming on at night is of the greatest importance, especially when it wakens the sufferer at a definite hour. This does not occur in the purely neurasthenic type.

I have never failed to find a well-defined ulcer where typical night pain was complained of.

Pain which radiates into the back is also of special value, and in my experience has generally been associated with an ulcer on the lesser curvature or on the posterior surface of the stomach. I cannot, however, dogmatize on this point. It is merely the impression that has been left on my own mind.

I have operated on several cases of long standing, two of them with hour-glass stomach, in which the constriction would scarcely admit a single finger, who stoutly maintained they had never vomited. Pain was their one and only symptom, and as years went by it became steadily worse. "Hunger pain," a gnawing, aching, or burning pain, coming on two or three hours after food, relieved by taking more food, soda, or even a warm drink, is, when typical in its manifestation, especially if it come on at night, almost pathognomonic of duodenal ulcer.

The following case, however, shows that we must exercise caution ere expressing a dogmatic opinion:

A young married lady, aged twenty-nine, visited me on February 28, 1910, accompanied by her husband. She informed me she had come to arrange for an operation for duodenal ulcer. She had seen several medical men, had tried milk diet, and rest in bed, without benefit.

Her daily history, with slight variations, was as follows:

Quite comfortable when she got up in the morning; breakfast 9 o'clock, pain coming on about 11.30 to 12 o'clock, and getting worse till dinner at 1 o'clock. This meal at once gave relief, and she was quite comfortable till between 3 o'clock P. M. and 5 o'clock P. M., the interval depending on the nature of her dinner. Once the pain began it steadily got worse, so that if she happened to be down town shopping she was obliged to have afternoon tea, the result of which was prompt relief. She took her ordinary tea about 6.30, after which she generally remained well, but occasionally the pain came back about 8 o'clock. It, however, never came on after she went to bed nor wakened her at night. She had slight tenderness over the right rectus at the level of the umbilicus. This being below the usual site, I inquired whether she ever had an attack of appendicitis, but she could recollect nothing of the kind. At operation March 6, 1910, her family medical attendant being present, we found a healthy stomach and duodenum. The appendix was 4½ inches long. At a point 1 inch from the cæcum it was tightly constricted, the remaining 3½ inches was distended to the thickness of an index-finger, and the tip was fixed by adhesions. The appendix was removed. She made a rapid recovery, and her medical attendant informs me she has remained well since the operation.

This history at first sight appeared quite typical. The absence of night pain, and the position of such tenderness as appeared to be present, suggested the possibility of an appendical origin. Our incision was therefore made through the right rectus opposite the umbilicus, so that it could be extended up or down as required.

Another condition which sometimes gives rise to a false "hunger pain" is that arising from a number of smooth gall-stones in the gall-bladder. Two or three hours after a meal, when the stomach contents begin to pour freely into the duodenum, the gall-bladder contracts in order to meet the extra demand for bile; and in the presence of calculi this contraction may be associated with a dull gnawing pain. Other symptoms, however, on careful analysis generally suffice to differentiate between the pathological lesions.

Fortunately an error in diagnosis is of little importance in view of the treatment. Either condition calls for surgical interference, and the same incision, *i.e.*, a vertical one, through the right rectus exposes both gall-bladder and duodenum. I have twice had to remove gall-stones after completing a gastrojejunostomy. One of these was in the present series.

Now we come to the question of *local tenderness*. When present, tenderness on deep pressure is a sign the value of which cannot be overestimated. Unfortunately I have only found it in about 10 per cent. of my cases, and a careful investigation on this point has been made by me for some years. When typical, it has invariably been associated with some localized acute peritonitis around the ulcer.

An ordinary chronic indurated ulcer is *not* tender on pressure any more than a chronic appendix exhibits tenderness. Just as the onset of an acute manifestation in an old quiescent appendix is heralded by local tenderness and rigidity, due to peritoneal involvement, so too does epigastric tenderness and rigidity indicate clearly and decisively that there is danger ahead. The ulcer is threatening to perforate; inflammatory reaction is taking place to seal and secure the danger zone.

In every instance in which this symptom was well defined the presence of recent peritonitis with inflammatory lymph was easily demonstrated to every one present at the operation.

If this lymph becomes organized into a firm adhesion the tenderness gradually disappears.

I wish to lay it down as a trustworthy clinical rule that tenderness is a danger signal, and that severe or persistent tenderness is one of nature's calls for help, and if neglected, the next and unmistakable call may be the tragedy of perforation.

Local hyperæsthesia, to which considerable weight is attached by some writers, was only present in about 3 per cent. of the cases examined by me. If present, both at the anterior and posterior terminations of the same spinal nerve, it is a very valuable sign, as it serves at once to eliminate neurasthenia. It is almost inconceivable that any one without a minute knowledge of anatomy could accurately locate tenderness along a single nerve in the absence of a pathological cause.

Hemorrhage has been distinctly noted at some period of the illness in 40 of my 110 cases. Allowing for the possibility that it may have been overlooked in some instances, I think it may fairly be estimated to occur in 40 per cent. I of course, only refer to visible blood. The regular examination of the fæces for microscopic traces of hemorrhage is never likely to be anything but an exceptional procedure, and is therefore of little practical value to the general practitioner.

In all my private and most of my hospital cases, a routine examination of the stomach contents has been made. Except in cases of dilatation, and to enable me to exclude malignancy by ascertaining the presence or absence of free HCl, I am bound to say that the information obtained has not been so helpful, from a practical stand-point, as I had at first anticipated.

Before deciding on such a serious step as operation, I think the stomach tube should be called to our aid in all but exceptional circumstances, and a chemical test should be made, so that nothing known to science may be overlooked.

Coming to the important question of treatment, I wish to lay down the rule that, in my view, gastric ulcer is essentially a medical disease. A very large number of these cases are curable by medical means. It is only when the complications arise, when relapses are frequent, or when the disease has become chronic that surgery has any vocation in non-malignant disease of the stomach. On the other hand I know of nothing more striking than the promptness and thoroughness of the relief which follows a well-planned operation on a stomach which is the seat of a chronic ulcer or its sequel.

Before discussing this question I would like to raise a point as to medical treatment. Is the stomach washed out as often as it should be? If properly used the stomach tube is not nearly so difficult to swallow or so uncomfortable as might at first sight appear. The application of a solution of cocaine to the soft palate and epiglottis, the assurance that there is no danger, and above all the carrying out of the instruction to breathe through the nose, will enable a patient to go through this ordeal even for the first time with very trifling discomfort.

To wash out the stomach each night, thoroughly empty it of acid contents, and minimize the effects of gastric stasis, which is present in a greater or less degree in all of these cases, is, I believe, good treatment. Contrary to popular opinion I do not consider hemorrhage a contraindication to this practice; I have frequently used it in cases subject to hæmatemesis, and have seen no ill effect.

Hæmatemesis is still best treated by medical measures. Of these I do not hesitate to say that in my experience the subcutaneous injection of normal horse serum has been incomparably superior to all others; 20 cc. of the serum may be given with an ordinary antitoxin syringe at the outset, and repeated night and morning, or oftener if desired. This need not supplant other well-known medical remedies, but should never be omitted when the bleeding is at all dangerous.

Administration of ice so constantly resorted to seems to do more harm than good. Small quantities of adrenalin at frequent intervals, by the mouth, freely diluted, small doses of morphia, and the calcium salts seem to me to have been of some benefit.

As to surgical treatment, it is not my intention to discuss the details of the operation now so well elaborated. These principles I wish to lay down:

(1) Gastrojejunostomy should be performed, but this alone is not sufficient except in cases of simple pyloric stricture.

(2) The ulcer should be dealt with, either by (*a*) excision; (*b*) infolding.

(3) Where no pyloric obstruction already exists, partial closure should be brought about by a running suture involving the sphincter muscle, so as to offer an obstacle to its free dilatation, and thus encourage the gastric contents to leave the stomach by the new opening provided for that purpose.

(4) An examination should systematically be made for a chronic inflammation of the appendix or other lesion likely to cause subsequent reflex vomiting. Any such cause should be removed. The appendix can quite easily be removed in all but exceptional cases through an incision in the right rectus, the lower end of which need not extend more than one-half to one inch below the umbilicus. This incision through the right rectus controls the gall-bladder, stomach, and appendix.

It is very surprising how frequently a chronic appendicitis has been found in my later cases where it has regularly been looked for. Thus since January, 1910, I find I have removed the appendix in 19 out of 48 cases.

In my earlier practice I was content to leave the ulcer to take care of itself and simply perform gastrojejunostomy. I am now satisfied this is not ideal surgery. Our aim should be to leave the mucous surface of the stomach as far as possible intact. It is scarcely reasonable, for example, to expect digestion to proceed normally in a stomach, part of whose posterior wall is formed by the pancreas, and whose movements are hampered by extensive adhesions. To dissect such a stomach off the pancreas is a very difficult operation, and results in a large hole being made in the stomach, which requires to be closed like a perforation.

At first I confess I shrank from this apparently risky procedure, but now I do not hesitate to undertake it, and the result fully justifies the time, trouble, and anxiety expended.

Excision of a chronic ulcer is by no means so simple a matter as the advocates of this as a routine method would have us believe. The operation is easy and attractive in a picture where all the clamps are applied with delightful accuracy, and the subsequent line of suture leaves a beautifully shaped stomach. This is not so in actual practice, as any one with experience of these cases can testify.

Where excision gives rise to difficulty, I therefore content myself with infolding the ulcer, a proceeding which if efficiently carried out is, as I have elsewhere demonstrated (*Trans. Roy. Irish Academy of Med.*, 1901, page 142), equivalent to excision, and at the same time easier, quicker, and probably safer. The effect of infolding is to secure complete rest to the ulcerated area, though as I have elsewhere pointed out (*B. M. J.*, Sept. 30, 1908) neither excision nor infolding is an efficient operation in itself. It should therefore invariably be associated with gastrojejunostomy.

This latter operation is now so well established a procedure, the broad principles so well recognized, that it requires little comment. At the same time I know of no operation in which the subsequent comfort of the patient depends so much on little details. To these I need not here refer. One point, however, has recently been forcibly impressed upon me. I operated on a man in 1909 for pyloric carcinoma, both layers of suture were done with linen thread as is the usual practice. He made a good recovery, and resumed his work as a car driver. One year later he was readmitted to the hospital with general peritonitis, due to perforation of the large intestine by a malignant ulcer. At the autopsy we found the gastrojejunostomy opening in perfect working order. The inner or through-and-through suture still persisted, and was hanging into the opening very much like the handle of a bucket. This is as far as I am aware the longest authenticated duration of such a suture. Such persistence is clearly undesirable, and though the absence of free HCl in the malignant stomach may possibly account for it, I have since then used fine chromicized or formalin iodine catgut for this purpose, and found it quite satisfactory.

Several cases of hour-glass stomach are included in my list. These I now always treat by a double operation—a modified gastroplasty followed by gastrojejunostomy *into the lower pouch.*

In all operations the abdominal wound is closed by three or more layers of catgut suture, either formalin gut, boiled in alcohol and stored in iodine and spirit, or chromicized catgut being used. Additional support is given by two or three deep silkworm gut stitches, which, however, do not penetrate the peritoneum. Sutured in this way the abdominal wall is absolutely secure. The patient may safely be allowed up in eight to ten days.

After-treatment.—All cases are nursed for two days in the Fowler or sitting position. If there is any evidence of shock, which is quite rare, continuous saline is administered, after Murphy's method, for twelve or twenty-four hours. Fluids are given freely by the mouth any time after six hours from operation. Thus it is quite common for my patients to have a cup of tea the evening of their operation.

Nursed in this position and treated in this way, anæsthetic vomiting is very rare. It probably does not occur in more than 5 per cent. Nothing indeed is more striking than the rapidity and easy recovery of these cases. They are allowed soups, jellies, puddings, porridge, bread and butter, eggs, etc., from the third day, and the second week chicken, fish and even potatoes.

I have shown that the immediate mortality should not exceed 2 per cent. What about the after-progress? We have to admit that some complications do arise and finally that a few cases, probably not more than 3 to 5 per cent., derive no benefit. The worse the condition found at operation the more striking and complete the relief. The only troublesome sequelæ in my experience are two—(*a*) peptic ulcer of jejunum, (*b*) regurgitant vomiting.

I have had three instances of jejunal ulcer. All of them were operated on before the year 1907. Of these cases two were treated by myself, by excision of the junction containing the ulcer, closure of the posterior stomach opening, and substitution of an anterior Y gastrojejunostomy. Both recovered, and have since remained well. The third, a policeman, operated on for dilated stomach in November, 1907, was admitted to hospital for perforated jejunal ulcer on December 9, 1910. Mr. Kirk operated on him successfully, and he left the hospital in good health six weeks later.

These cases were all amongst my earlier operations, where I was making a longer jejunal loop than I now do.

This complication is undoubtedly a very serious drawback to the operation, but I think by use of an inner catgut suture, and by making a very short loop, it should be practically eliminated.

Regurgitant vomiting is a very troublesome sequel. It is quite rare in the modern operation where the jejunal loop is very short—"no loop." When present is due to:

(*a*) Obstruction by an adhesion causing an acute kink in the descending loop of the jejunum.

(*b*) Reflex irritation from an appendix, ovary, or other distant cause.

(*c*) Persistence of former hysterical vomiting.

If due to an adhesion it may sometimes be relieved by washing out the stomach and massage. The injection of fibrolysin into the abdominal wall has appeared beneficial in two cases in which I have used it. Failing this, the cause must be removed by operation.

Now as to the permanency of cure. I am afraid it would be unwise to contend that once a person has been operated on for gastric ulcer, perpetual immunity from all and every type of indigestion can be guaranteed. My present list is too recent to admit of any inference on this point. It has been drawn up rather with a view to establish the comparative safety and immediate benefit of the modern operation.

I have many cases, however, operated during the past eleven years who continue in perfect health. One lady operated on in 1900, after years of suffering, has since married, has a family of five children, but has remained quite free of stomach trouble. Three cases operated on by me have been accepted by three different first-class British insurance companies without any addition to the usual premium.

I venture with confidence to submit that sufferers from chronic ulcer of the stomach or duodenum, which has failed to respond to medical treatment, may confidently be recommended to consider operative treatment, the prospects being an immediate risk not exceeding 2 per cent. with 90 per cent. probability of complete and permanent cure.

EARLY DIAGNOSIS OF CARCINOMA OF THE COLON.

BY JOSEPH BURKE, M.D.,
OF BUFFALO, N. Y.

Attending Surgeon, Sisters' Hospital.

INASMUCH as a study of cancer generally is most interesting and instructive, cancer of the intestines, on account of its anatomical complications and variable symptomatology, should prove doubly so; particularly does this obtain when we take into consideration not the theory of the subject but the practical side of it, and this I will endeavor to do. The early diagnosis of any abdominal carcinoma is in many instances life-saving to the patient, in others a source of positive judgment to the surgeon or physician in the fatal prognosis. The early diagnosis of primary cancer of the liver, spleen, or pancreas is seldom positively made, because cancer in itself gives rise to no characteristic symptoms, its resulting complications being sometimes first manifested long after the beginning of the malignant process; but in carcinomata affecting the gastro-intestinal tract, depending entirely upon the situation as well as the degree of the progress of the growth, the early diagnosis is in a great many instances positively determined, and the results of the early surgical attack a boon to the patient and a source of gratification to the surgeon.

The early symptoms of cancer of the colon are for a long time very indistinct and difficult of interpretation, and, apart from the anatomical site of the cancer, they depend upon three factors: first, stenosis, second, accompanying intestinal catarrh, and third, ulceration of the growth of either the mucous membrane or externally into some other organ. This last fact brings to my mind a case (J. W., aged 55 years) of carcinoma of the sigmoid that I saw about a year ago in which the patient's first symptoms were those of colitis and loss of weight and strength. It was only when distressing bladder disturbances began that he sought medical aid and the true nature of the pathology was suspected because there had occurred an ulceration of the growth from the sigmoid into the bladder with the resulting communication of the interior of the colon with the interior of that viscus. In this case when the patient complained of diarrhœa he affirmed also that the colicky pains preceding and accompanying the emptying of the bowel radiated to the anus. Had I interpreted this symptom as Rudolph Schmidt points out, my suspicion of sigmoid cancer would have been immediately aroused. In this instance no tumor could be determined by abdominal palpation for a long time, and rectal examination showed no pathology. It was only when severe cystitis developed and gas escaped through the urethra that the diagnosis was made.

When a pale patient, who up to a certain given moment has enjoyed perfect health, particularly as regards his digestion, suddenly, with or without dietary indiscretion, *e.g.*, eating of flatulence-producing vegetables, begins to suffer from colicky pains in his abdomen with rumbling noises, and either in addition to obstinate constipation or diarrhœa notices a great loss of weight and increasing muscular weakness, cancer of some portion of the colon should be immediately suspected; when the stools contain blood or mucus or pus, or all three at the one time, the further suspicion of cancer is strengthened; and if a mass is found in any part of the abdomen with or without visible peristalsis, the almost positive determination that a cancer is present is made. In this connection I want to emphasize the fact that tumors of the sigmoid are very rarely palpated in the early stages; what we do sometimes feel and interpret as sigmoid cancer is either chronic inflamed and enlarged colon or scybala above the strictured bowel; that not always where we find a mass in the abdomen does it signify the exact location of the suspected cancer, as was demonstrated in a case of another carcinoma of the sigmoid flexure I once saw, in which a hard mass could be palpated in the left upper quadrant and the diagnosis of cancer at that point was made, but the autopsy revealed a circular scirrhous carcinoma of the sigmoid, and the mass that appeared in the upper [illegible] tion of the descending colon was hardened fæces. This point is important on account of the surgical attempt to relieve the pathological conditions, and the placing of the necessary incision. If a doubt exists as to the anatomical situation of this tumor, the X-ray in recent time has become a valuable adjunct to our diagnostic armamentarium, as a case which I will describe here will aptly illustrate.

Mr. P. Z., Lockport, N. Y., aged forty years; occupation, broom-maker.

Family History.—Gives no evidence of malignant disease.

Previous History.—Patient affirms that he never suffered from any illness up to the time of the present one. No infections.

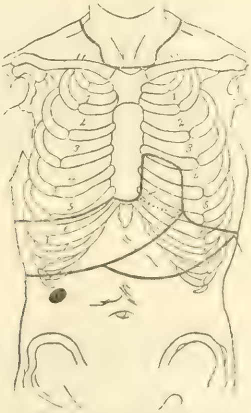
Present Illness.—About a year ago patient began to complain of gas and pain in the right side of the abdomen; the exact localization was indefinite, but the pain was referred to the right quadrant. The bowels have been loose, and lately there has been a watery diarrhœa, and for this reason as well as for the colicky pains in his abdomen, he seeks the advice of a physician. His appetite is very good. Up to one year ago patient's digestion was perfect; he never suffered from bowel trouble until then, when he suddenly noticed this looseness. Lately he complains of a feeling of weakness and is easily fatigued upon exertion. He has lost 28 pounds during the past year. He has never passed any blood; the only difference in the nature of the alvine discharges was that they had become watery. There has been no nausea, no vomiting.

Status Præsens.—Patient shows a peculiar, almost yellowish, paleness of the skin and mucous membranes. He is emaciated. Conjunctivæ not icteric; tongue somewhat coated but moist. There are no palpable lymphatic glands in the neck, nor in any other part of the body. Skin lax, shows loss of fat. Lungs and heart normal. Abdomen: The abdomen is flat, no ascites; there is no visible peristalsis. On the right side, just above a line drawn through the umbilicus and below the end of the eleventh rib, is a slight elevation (Fig. 1). Palpation reveals this to be a hard, somewhat tender mass, which is irregular in outline and movable, but is not attached to the lower border of the liver. It is movable during inspiration; it can be held fixed during expiration. Bimanually, ballottement can be distinctly felt. There is no pulsation over the tumor, and it cannot be made to disappear under the ribs. There is no rigidity of the right rectus muscle. There can be heard no gurgling, no peritoneal friction sounds over the tumor. Urine normal. Liver and spleen not enlarged. Fæces show no pathological elements, no blood. Blood: secondary anæmia; hæmoglobin 75 per cent.

Considering in this case:

(*a*) Sudden disturbances of bowel function, after previous perfect health; (*b*) loss of weight, 28 pounds, and increasing muscular weakness; (*c*) colicky pains in abdomen; (*d*) secondary anæmia, and (*e*) tumor in the right hypochondrium—the diagnosis of malignant tumor was immediately suspected. The fact that the tumor was hard, tender, and irregular, not round and smooth in outline, passively movable, and could be held fixed during expiration, excluded gall-bladder in the diagnosis; and, further, the fact that the mass could not be pushed up under the ribs and made to disappear, argued against kidney origin; but ballottement characterizes kidney tumor, so does a mass which moves downwards with inspiration and can be held fixed during expiration, and both of these signs were present in our case. Coupled with this the observation that there was no blood nor mucus nor pus in the stools, no peritoneal friction sounds heard over tumor, no peristalsis visible, caused us to hesitate a little in our positive declaration that we had to do with

FIG. 1.



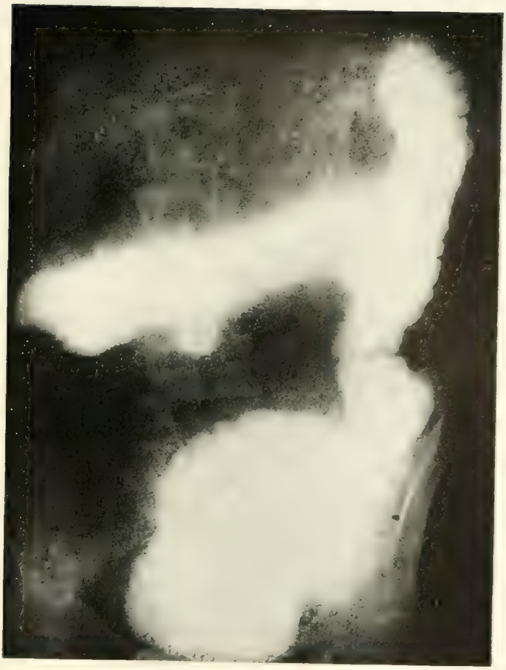
Case P. Z., outline of tumor.

hepatic flexure carcinoma. I had two X-ray plates made of the colon which I present here; it will be seen how beautifully the differential diagnosis was positively determined. In Fig. 2 will be observed the rectum, sigmoid, descending and transverse colon, and then an abrupt cessation of the shadow, as if the bowel were cut off at the hepatic flexure; it will be noticed where the cæcum should be seen are two or three fine shadows, showing a trickling of bismuth through the constricted tumor mass at the flexure.

In a second plate (Fig. 3) taken fifteen minutes after the first, will be noticed a little more distinctly shadows of the bismuth that has passed through after fifteen minutes retroperistalsis. The X-ray, as may be seen, makes very plain that we had to do with constriction of the hepatic flexure of the colon and excludes the kidney. I want to say here that a sometimes very valuable aid in the differential diagnosis of tumor of colon and kidney, that of artificial inflation of the colon, was not done because we thought it unnecessary and dangerous in this instance. Immediate operation was advised and it was done three days following the X-ray examination.

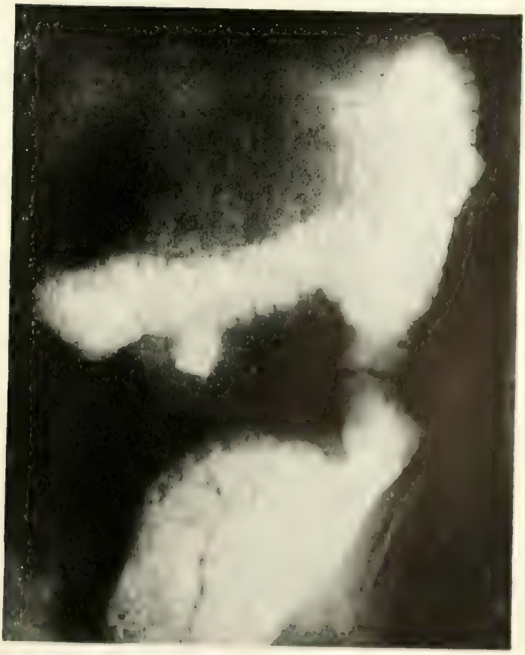
Operation at Sisters' Hospital, August 22, 1911: Upon opening the abdomen in the right semilunar line, with the middle of the incision corresponding to the level of the umbilicus, I found a hard mass about the size of a lemon which was part of the hepatic flexure of the colon. It was attached by adhesions to the posterior wall of the abdomen, but was with some difficulty freed. The cæcum, ascending colon, and a part of the transverse colon were made movable by an incision into and freeing of the parietal peritoneum and delivered. The appendix was somewhat congested, the cæcum dilated, and the ascending colon contracted to about half its length, a point which Moynihan calls attention to in his work. The ileum was divided between clamps as was also the transverse colon; the lower end of the ileum, the cæcum, the ascending colon with tumor, and part of the transverse colon were removed, as well as some enlarged glands of the mesentery. The ends of the remaining parts of the ileum and transverse colon were closed and inverted. Then a side-to-side anastomosis of the ileum with the transverse colon was made in the direction of the normal fecal current. I made the anastomosis about two and one-half inches in length, using

FIG. 2.



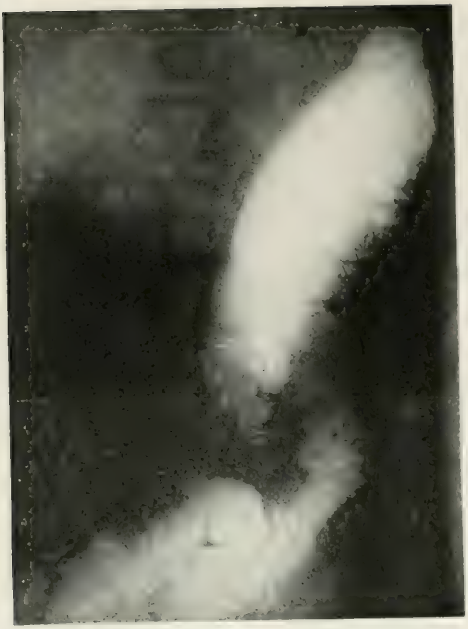
Case P. Z., bismuth test, before operation.

FIG. 3.



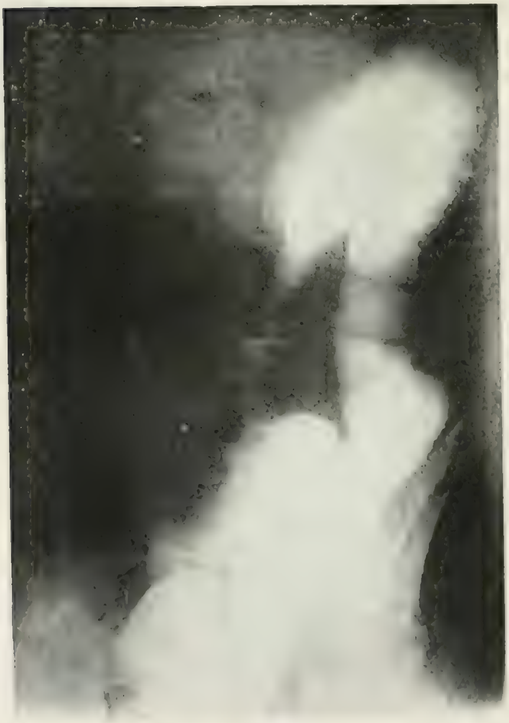
Case P. Z., bismuth test, before operation. Plate taken fifteen minutes after Fig. 2.

FIG. 4.



Case P. Z., after operation.

FIG. 5.



Case P. Z., after operation. Plate taken ten minutes later than Fig. 4.

the clamp method and Connell suture, reinforced all around with Lembert suture. After a thorough toilet of the peritoneum the wound was closed in the usual manner.

On the twentieth day after the operation, the day previous to patient leaving hospital, cured, two X-ray plates were made, to which also I wish to call attention. In this plate (Fig. 4) will be seen the bismuth-filled ascending and transverse colons, and some of the bismuth forced through the anastomosis opening into the ileum. In the plate (Fig. 5) taken ten minutes after Fig. 4, the half of the transverse colon nearer the anastomosis is seen contracted and almost empty of bismuth, while the ileum is seen to contain much more bismuth than in Fig. 4.

I wish to thank Dr. Leonard Reu for these excellent X-ray pictures.

Differential Diagnosis.—The differential diagnosis of cancer of the colon can best be considered by a study of the flexures, situations where the growths most frequently occur.

Beginning at the cæcum, we find two pathological conditions that can simulate carcinoma, appendicitis in old people and ileocæcal tuberculosis. There are cases of appendicitis, though very rare, that cannot be absolutely determined in the early stages, and only when an acute recurrence is present is the benign nature of the disease determined; there are others in which the differential diagnosis between cæcum carcinoma and appendicitis in the beginning gives rise to great speculation, when there exists elevation of temperature and sometimes repeated chills, as well as acute local pain. But here as well as in all cases the taking of a very careful previous history up to the time, and exact detailed symptomatology of the present illness, ought to be of great diagnostic aid. Some observers have claimed that temperature in itself speaks against carcinoma, but in this they absolutely err, because temperature elevation is a not seldom phenomenon in gastro-intestinal cancer, as Freüweiler, of Zurich, conclusively demonstrated. Fromme, of Halle, claims that this fever in cancer is due to destruction of the primary tumor, large lymph-channels being opened up, and a great amount of bacteria brought to the lymph-glands and their toxins permeating the blood. Hence I would suggest in the differentiation of carcinoma from appendicitis in elderly people, that we pay absolutely no attention to the temperature as against carcinoma. It matters little, however, to the surgeon as both conditions demand early surgical attack, and one who opens the abdomen to operate an appendix ought to be ready to do a radical operation in case his pathology proves to be cancer. Again, as Tuffier has reported, there are cases of malignant diseases of the cæcum with abscess formation.

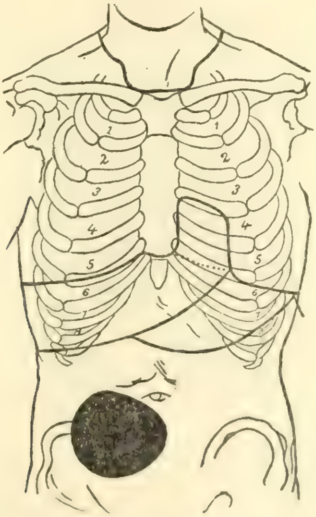
Since writing the above paragraph concerning the differential diagnosis of cæcum carcinoma in which fever is present as a prominent symptom, I have seen and operated on a case, the history of which I think ought to be given in detail. On account of the suddenness of the onset of abdominal pain, temperature 103°, pulse 105, and exquisite tenderness on palpation, as well as a well-defined mass in the right iliac region, a diagnosis of acute appendicitis with perityphlitis was suspected by another physician who saw the patient on the second day of the acute attack. I was invited by the attending physician to see the patient, on the twelfth day, and after going into the history of the case minutely, obtained the following data:

September 28, 1911: Mrs. C. O'B., fifty years of age, married, one child twenty-two years of age. Father died at seventy-eight of paralysis. Mother at sixty-two; cause indefinite. Patient as a child never had any infectious diseases until she was fourteen years of age, when she suffered from double quotidian malaria. Last menstruation five months ago.

Present Illness.—Up to one year ago she was perfectly well and able to do her household work, including washing, without fatigue. At that time and up to six months ago she noticed that she was losing weight and that she was easily fatigued in doing her work, and had to give it up. Her daughter noticed that her complexion was becoming paler and that she looked bad. About six months ago she noticed that unless she took a physic (Cascara) every day her bowels would not move. This obstinate constipation has persisted up to the present time; there has been no diarrhœa. She never noticed blood nor pus nor mucus in the stool. She has complained of pain when about to urinate and griping pains just before the bowels act. She has never vomited, but lately her appetite has been poor. Twelve days ago she began to complain suddenly of cramps in her right iliac region, which I have already described.

Status Præsens.—The patient has a yellowish, pale, anæmic color. The mucous membrane is pale; there is no jaundice of the conjunctivæ; no glands palpable in any part of the body. Tongue clean and moist; heart and lungs normal.

Fig. 6.

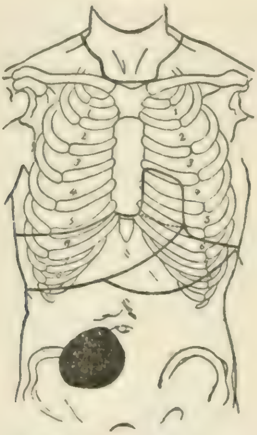


Outline of tumor Sept. 28, 1911.

Abdomen: Liver and spleen not enlarged; inspection of the abdomen shows a rounded prominence, the centre of which corresponds to a point an inch below McBurney's point. There are no visible peristaltic waves; palpation reveals this swelling to be a hard, exquisitely tender, somewhat uneven mass, which can be slightly moved from side to side (Fig. 6). The mass extends about a finger-breadth above a line drawn through the umbilicus, and extends to the left about an inch beyond the middle line. It measures in its longitudinal diameter 5 inches, in its transverse diameter 4½ inches. Over the centre of this tumor there is a dull tympanitic note. The skin and abdominal wall are movable over the tumor, particularly near the anterior superior spine. There is no rigidity of the right rectus muscle.

October 5: Temperature, 99°; pulse, 118; respiration, 20. There is less pain complained of. Left lateral position causes dragging pain referred to the site of swelling in the right iliac region. The mass is not so tender to palpation, and its limits are more confined than five days ago. It goes about to a line drawn through the umbilicus above and not quite to the middle line laterally (Fig. 7). The tumor is not respiratory movable. There is no rigidity of the right rectus muscle. The skin and underlying structures comprising the abdominal wall over the site of swelling can be moved as if separated from and gliding over the tumor. Blood shows the following: Hæmoglobin, 75 per cent.; white cells, 10,900; polymorphonuclears, 81 per cent.; large, 13 per cent.; small, 6 per cent.; erythrocytes, 3,500,000. Stools contain no blood, no mucus, no pus. Urine negative, Diazo reaction not present.

Fig. 7.



Outline of tumor Oct. 5, 1911.

Considering in this case: (1) no previous infections excepting malaria; (2) loss of weight, 29 pounds in six months; (3) obstinate constipation; (4) increasing muscular weakness; (5) griping pains just before defecation; (6) the absence of vomiting, especially at the onset of and during the recent febrile illness; (7) yellowish pale color of skin; (8) the fact that the tumor persisted even after the cessation of the fever; (9) the clean moist tongue, which personally I have never seen in any acute abscess case; (10) and this is the most important point and the one on which I place the greatest dependence, and which as far as I am aware has not had attention called to it in the literature, namely, the fact that the skin and underlying structures of the abdominal wall over the site of the swelling could be moved by the palpating hand as if separated from, and gliding over, the tumor. I have never observed a case of abscess in the abdomen large enough to see and outline where the muscles over it were not on guard and which could be moved as above described. I did not therefore hesitate to affirm that we had to do with, not appendicitis with abscess, but carcinoma of the cæcum, a diagnosis the correctness of which was demonstrated at operation. Fever and 81 per cent. polymorphonuclear leucocytes in a count of 10,900 and still no acute abscess are observations to be considered in a negative way.

I made an incision through the middle third of the right rectus muscle, splitting the fibres. Upon opening the abdomen I found a mass about the size of two fists. The tumor proved to be a carcinoma of the cæcum. The omentum attached to the tumor mass was ligated off in sections. The tumor itself was not adherent to the surrounding structures except slightly to the posterior abdominal wall. The cæcum was delivered, the parietal peritoneum external to it was cut and freed, and the cæcum and ascending colon raised upward and toward the median line, the mesentery of the ileum and of the cæcum were ligated in sections with heavy celluloid linen. Inasmuch as the mesentery of the terminal ileum was short I removed about 14 inches of the ileum, the cæcum with mass, and ascending colon, between clamps. The end of the remaining colon I closed with a continuous suture; touched the line with carbolic acid and alcohol, and then with the Lembert continuous suture buried the stump. The end of the ileum was treated in like manner, and a side-to-side anastomosis made of the ileum with the transverse colon in an isoperistaltic direction. The anastomosis opening was about an inch and one-half in length in its interior; the omentum was sewed over the anterior suture layer of the anastomosis. The toilet of the peritoneum was made in the usual manner and the abdominal wound closed

The post-operative history is as follows: During the first forty-eight hours patient vomited three times, complained of no pain, no bladder disturbances; the abdomen was soft, and liver dulness normal. The pulse ranged about 120, respiration 24. At the end of the second day an enema brought some gas and fecal colored water; on the third day, after a soapsuds enema, patient passed considerable flatus and some fecal colored matter. On the third day the pulse suddenly became accelerated, respirations went up to 50, lips became cyanosed, and signs of hypostatic pneumonia developed, until the fourth day, when death occurred, the cause of death being hypostatic pneumonia. A postmortem was not allowed.

I have no doubt that had I been called to attend the patient in the early days of her febrile illness, instead of on the twelfth day, I would have been deceived by the clinical picture presented, and I am sure there is no doctor who would not have suspected an acute appendicitis or a perforation of the cæcum with abscess formation, had he been called early to see the case, because we do not know definitely whether or not at that time there had been a complicating local plastic peritonitis. I do not know how to explain the reduction of the size of the mass from September 28 to October 5, as shown in these pictures, except possibly an acute plastic peritonitis existed, in the omentum, which was found adherent to growth, and absorption of the exudate took place.

In differentiating cancer from tuberculosis of the cæcum, however, most careful examination of both lung apices for healed tubercular processes, the presence of the Diazo reaction in the urine, the finding of the tubercle bacilli in the stool, and lastly the positive Von Pirquet reaction, should guide the surgeon in the right direction. There are cases of ileocæcal tuberculosis that even after removal cannot be differentiated from cancer except by careful microscopical inspection.

The differential diagnosis of hepatic flexure carcinoma we have already discussed in detail in our case report; the chief causes of error are gall-bladder and liver neoplasms, and kidney tumors.

I saw a case (Mr. C. W., sixty-three years old), however, about two months ago, that, on account of a hard painful mass about at the hepatic flexure, the thought of carcinoma of that part was taken into consideration, because the patient had lost considerable weight within a short period, was obstinately constipated, and complained of colicky pains and gas in the abdomen; but from the fact that he was jaundiced somewhat, that the tumor could not be separated from the liver and was not movable, that years before he had had an attack of what I judge was acute biliary colic, I made a diagnosis of gall-stone disease with Riedel's lobe; operation revealed impacted cystic duct stone, a Riedel's lobe, and the mass which I misinterpreted was omentum which was infiltrated, attached to and enveloped the gall-bladder and lower border of the liver.

Carcinoma of the transverse colon is so exceedingly rare that confusion with gastric carcinoma of the greater curvature is of seldom occurrence. The gastric symptoms, such as coffee-grounds vomit, the Boas-Oppler bacilli, and the absence of free HCl, and the presence of lactic acid in the stomach contents, need only to be mentioned to differentiate it from stomach cancer; then too the X-ray ought to be an aid, as a case I shall briefly mention will illustrate.

The patient (Mrs. M., forty-five years of age) complained of great loss of weight and rapidly diminishing strength, and a somewhat painful lump about the size of a lemon which appeared in the middle line of the abdomen just above the umbilicus. She complained of no gastric symptoms. On account of the mobility of the tumor mass and the constipation which was present, the idea that possibly a transverse colon carcinoma existed was thought of. The X-ray pictures showed definitely a greater curvature carcinoma and normal colon.

Of course there are cases of carcinoma of the transverse colon that rupture into the stomach and give rise to fecal vomiting, but with the diagnosis of such a condition, inasmuch as it concerns an advanced stage of the disease, we have in this paper nothing to do.

Carcinoma of the splenic flexure I have never personally observed, but Schmidt says the only conditions that can be mistaken for it are carcinoma of the stomach and of the spleen. Here again the X-ray should prove of great assistance.

In malignant disease of the sigmoid where the early pains are referred to the bladder and left testicle, the error of confounding it with nephrolithiasis can obviously be made; but the absence of pathological urinary changes, blood, pus, etc., the negative X-ray findings as regards stone in kidney or ureter, would exclude kidney colic at once.

In this paper I have endeavored to confine myself strictly to the practical side of the early recognition of colon cancer, and if I have digressed somewhat with the recitation of personal cases, it has been with the innocent intention to avoid theoretical discussion and quotations from authorities so called, and to give the results of my own clinical observation.

NON-TRAUMATIC LARGE HEMORRHAGE INTO THE KIDNEY SUBSTANCE OR ITS SURROUNDINGS.

BY RUSSELL STORY FOWLER, M.D.,
OF BROOKLYN, N. Y.

HEMORRHAGE into the kidney substance or in the neighborhood of the kidney commonly follows trauma; but *spontaneous hemorrhage* is so rare as to constitute a surgical curiosity. The etiology of such hemorrhage is found to reside in an arteriosclerotic condition of the kidney, as in Doll's second case; in acute nephritis, as in a case reported by W. H. Dickinson of congestive nephritis resulting from exposure, in which at the autopsy each kidney was found imbedded in a mass of coagulated blood which lay outside the capsule in the surrounding cellular tissue; the hemorrhage was caused by a rupture of the capsule from congestive swelling of the kidney. Rupture in each kidney was at the inferior portion. A tumor of the kidney may cause hemorrhage, as in the case operated by Tuffier, a man of forty who had a hemorrhage into the right kidney from a round-celled sarcoma of the kidney. The case terminated fatally. A fourth cause is found in rupture of an aneurism of the renal artery or one of its branches either before entering the kidney or into the kidney substance. In the *Philadelphia Medical Journal*, May 5, 1900, Keen reported a case of aneurism of the renal artery and gave a résumé of twelve other cases: Titius (S. C.), Gossett, Leudet, Danner, Catalog Museum St. Barth. Hosp., London, 1882, i, 234, Specimen 1636, Armstrong, Turner, Hochenegg, Oestrich (two cases), Grüber, Hahn. Morris, in *The Lancet*, October 6, 1900, reported twenty cases (Hilton, Morris, Rouppe, Danyau, Mounier, Murray, Dourlin) and the thirteen cited in Keen's paper. The case in Morris's paper known as the Reeves case is the same as the Turner case in Keen's paper. The Titius case in Keen's paper seems to be a reference to Nebel's case, the better history being in

Morris' paper. Skillern in the *Journal of the American Medical Association,* January 6, 1906, was able to add five cases (Deaver, Fulton, Abbott, Barnard's first case, and Barnard's second case). Since Skillern's paper but one new case has occurred—Markley, *Medical Council,* Philadelphia, 1909, iv, 225.[1]

Of these 26 cases (Keen, Gossett, Oestrich, two cases, Nebel, Armstrong, Markley, Turner, Hochenegg, Grüber, Hahn, Hilton, Morris, Rouppe, Danyau, Mounier, Deaver, Leudet, Danner, Museum Specimen, Abbott, Barnard, two cases, Murray, Fulton, Dourlin) six (Leudet, Danner, Museum Specimen, Oestrich, Abbott, Barnard) gave no symptoms traceable to aneurism, the aneurism being discovered at autopsy; three of these cases (Murray, Fulton, and Barnard's second case) are not completely enough reported to be of value. Ten cases (Turner, Hochenegg, Grüber, Hahn, Hilton, Morris, Rouppe, Danyau, Mounier, Deaver) show hemorrhage into the kidney immediately following severe injury, with recorded kidney symptoms at the time of injury and followed later by traumatic aneurism. In addition are five cases (Keen, Gossett, Dourlin, Armstrong, Markley), in which there was no history of traumatism and in which rupture occurred, which have sufficient data to be of clinical value. In the remaining two cases (Oestrich, Nebel) it is doubtful whether or not traumatism entered as a factor.

A synopsis of Markley's case is as follows:

History.—Male, aged seventy years, pain in the left inguinal region with enlargement of the spermatic cord. First pain had been in the left testicle. Pain increasing. Had had two or three attacks of gravel (?). Pain became rapidly worse. On the second day severe pains in the entire left side. Third day sudden excruciating pain with collapse. Pain over region of the kidney. Died four hours later. Autopsy showed aneurism of the renal artery just outside the kidney, with a deep convexity on the anterior surface of the kidney from pressure. The aneurism extended from the internal inguinal ring almost to the diaphragm.

September 19, 1909, there was referred to me a case which at operation proved to be one of spontaneous bleeding into the kidney substance, without any history of injury. The history of the case given below shows that there had been three attacks of lumbar pain similar to the one with which she suffered when referred to me, extending over a period of twenty years. The pathological condition found at operation was so unusual and the clinical picture so striking that no term seemed better to describe the condition than that of apoplexy of the kidney.

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[1] There has been some question as to the total number of cases reported, Skillern giving the total number of cases as 27 in 1906.

T. G., female, aged fifty-two, quite stout, was referred to me September 19, 1909, by Dr. Licht with the following history: Ten days before her admission she had noticed a slight dull pain in the back, which four days later became more severe; she then noticed considerable blood in the urine and several clots. Urination was accompanied by sharp cutting pain in the left lumbar region, radiating to the front of the abdomen and downward to the pelvis. Urination occurred three or four times daily, and the patient was not obliged to get up at night. The cutting pain in the back was worse at night. There was a chill followed by fever. Three days before admission there had been three attacks of vomiting. On the morning of admission the pain became localized to the left lumbar region, and there was considerable tenderness in that region.

The patient gave a history of having had a severe malaria twenty-five years before, lasting for two and a half years. She had had three attacks of lumbar pain similar to the present one, the first 20 years ago, the second 5 years later, and the third 6 years before the present attack. The third attack was the most severe. The history was in other respects negative.

Examination showed a tender, immovable tumor the size of a cocoanut occupying the site of the left kidney. The mass was plainly visible as well as palpable. Temperature, 98°; pulse, 104; respiration, 24. Urinalysis: specific gravity, 1025; color, red; reaction, acid; albumin, a trace; urea, 19 gr. to the ounce; microscopical, an abundance of red and white blood-cells; some hyaline casts; quantity, 45 ounces. Blood examination: hæmoglobin, 95 per cent.; leucocytes, 7800; differential, 75 per cent. X-ray examination negative, no stone discoverable. Permission could not be obtained for a cystoscopic examination, and the patient demanded immediate relief.

Although no history could be obtained of the sudden passage of a large quantity of urine following relief of the pain, and although the X-ray did not show a stone, it was thought probable that the case was one of hydronephrosis associated with calculus. Operation, however, disclosed a very different condition. A six-inch incision in the lumbar region was carried down through the transversalis fascia, and the kidney fat exposed. Immediately on opening the transversalis fascia there was a gush of a small quantity of fluid blood. This was sponged away, and a number of clots, about a double handful, removed from the kidney fat. The kidney fat was separated down to the kidney and the kidney brought up into the incision. There was considerable free bleeding. With the first and second fingers of the left hand pressing the pedicle of the kidney, the organ was examined. It was found that there was a rent in the capsule and in this rent a large clot shaped to the kidney. On account of the hemorrhage it was deemed wise to do a nephrectomy. The tissues surrounding the renal artery and vein were somewhat œdematous, the pedicle was ligated *en masse* with braided catgut. The kidney was removed, the wound cleansed from fluid blood and clots, and as there was some oozing from torn adhesions in the neighborhood of the diaphragm, the entire wound was packed tightly, the end of the packing being led out of the lower angle of the wound. The wound was then closed, except for its lower angle, with layer sutures. The packing was removed on the fourth day and a small strip reinserted, the wound healing *per primam* except at the point of the emergence of the packing. This granulated rapidly. The patient was out of bed on the twelfth day and went home on the eighteenth day. The one untoward symptom noted was some bladder irritation from concentration of the urine; this was remedied by the ingestion of large quantities of fluids and alkalies.

The kidney presents the following appearance: a tear in the capsule through which there had escaped a considerable amount of blood; a partially organized clot beneath the capsule, which had dissected the capsule on the convexity of the kidney loose from the cortex; this shows that the hemorrhage had extended through the rupture of the capsule; a small rupture at the lower pole of the cortex, through which the blood had escaped from the kidney structure; a cavity the size of an egg in the cortex filled with fresh blood-clot; a few small clots in the pelvis of the kidney and in the upper part of the ureter. This, as well as the presence of blood in the urine, showed that there had been some connection between the hemorrhage in the cortex and the pelvis. Such an opening, however, cannot be made out in the specimen. Dr. Arthur C. Holzman reports the microscopical examination as follows: (1) Section taken from upper pole of kidney away from the blood-clot shows no apparent change in the kidney structure. (2) Section bordering on blood-clot shows, first, the blood-clot, and bordering this, the broken-down structure of the kidney. Passing away from the clot, the normal structure of the kidney is perceived in a state of molecular necrosis apparently from pressure. Here the renal tubules are filled with blood and widely distended, others are collapsed from the pressure of the distended tubules. Still further externally is a zone of tissue, where renal tissue is unchanged except for the tubules which are enormously distended with blood, which passes off into normal renal structure. Nowhere is there an infiltration of round cells or fibrous tissue. The red blood-cells retain their form and are not broken down. (3) Section of blood-vessel (vein entering cavity) shows an atrophy of the coats. Otherwise no change.

ABSTRACTS OF OTHER REPORTED CASES.

In 1910 Dr. PAUL PICK described a case operated upon March, 1909, by Schnitzler. Schnitzler's case was that of a woman of fifty-three, who, during the menopause, had had violent hemorrhages. Eight years previously she had had an attack of illness with jaundice lasting four weeks, accompanied with violent pains on the right side of the abdomen. For a number of years she had been constipated. A few days before coming to operation, she had become suddenly attacked with violent pains in the right side of the abdomen. These pains were so severe that she became unconscious; she had since had continuous pain. There was no vomiting; the bowels had last moved four days before. Temperature 37.2°; pulse 72. The patient was of medium size, rather corpulent, of pale complexion. There was slight jaundice. The right side of the abdomen was somewhat distended. Percussion gave normal resonance over the spleen and stomach. Palpation revealed a somewhat enlarged liver; there was marked sensitiveness over the liver; this sensitiveness was more extreme in the right mammillary line below the liver, where there was also felt a resistance. Urinalysis was negative. A clinical diagnosis of cholecystitis was made. An incision over the region of the gall-bladder showed a firmly distended gall-bladder about as large as a child's head, but with no trace of recent inflammation or gall-stones. Exploring further it was found there was an extensive hæmatoma beneath the mesocolon and in the retroperitoneal connective tissue; the abdominal wound was sutured and an incision made in the flank for exploration of the kidney. Upon separating the fatty capsule there was found a large clot surrounding the kidney on all sides. After removal of the clot the kidney seemed quite normal. The origin of the bleeding could not be established. The after course was uneventful except for rather severe infection, necessitating a counter-incision. The patient finally left the hospital cured. Pick makes reference to seven other cases of a somewhat similar nature. The first reference to the subject is that of Wunderlich in 1856. Wunderlich included in the term "apoplexy of the renal covering," every hemorrhage in the neighborhood of the kidney.

HILDEBRANDT, in 1894, published the first case of perirenal hæmatoma; his case gave the following history: Female, nineteen years old, was suddenly attacked three weeks before with violent pains in the left side of the abdomen. There was considerable shock. The abdomen was greatly distended, and on the left side there was a firm elastic tumor projecting under the costal arch as far as the navel. There was no fever; urine was normal. On incision 1½ quarts of blood and blood-clots escaped. This hæmatoma had completely surrounded the left kidney, which, upon examination, proved quite normal. The wound was drained and the patient was discharged cured after eleven weeks.

DOLL, in 1907, under the name of "Apoplexy of the Renal Covering," describes two cases, both of which resulted fatally without operation. The first case, a man sixty years old, with advanced arteriosclerosis and chronic nephritis, was attacked with colic-like pain in the left kidney region. On the third day of his illness left pleuropneumonia supervened; on the fourth day there was observed an extreme distention of the abdomen, with a large tumor in the left side of the abdomen; on the fifth day the skin in the left lumbar region and the left half of the scrotum became blue; a few hours later the patient died. At autopsy there was found a retroperitoneal hæmatoma reaching from the diaphragm to the bladder; the hæmatoma consisted alternately of masses of fatty matter and blood-clot. Doll's second case was a man forty-one years old, also with arteriosclerosis and chronic nephritis, who was attacked with paroxysmal colic-like pains extending over the entire left side of the abdomen; on the second day a firm elastic tumor was noted in the left side of the abdomen; the patient seemed anæmic; on the fourth and fifth days there was great distention, and the skin over the left renal region became livid; the underlying parts were doughy to the touch. On the fifth day the patient died. Autopsy showed an intraperitoneal hæmatoma lying between the descending colon and wall of the abdomen, and connecting with a retroperitoneal hæmatoma, consisting of fatty matter and blood-clot extending from the diaphragm to the bladder; in the centre of this mass was found a small white kidney *in the capsule of which there was found on the upper pole a small tear.* This led to a small cavity which, as was proven microscopically, consisted of arteriosclerotic kidney tissue.

In 1908 JOSEPH reported a case of spontaneous hemorrhage into the kidney substance, the patient a man of fifty years who had suffered for years with gout. He was taken ill with violent pains in the right side of the abdomen; some days later there was fever and an undefined resistance on the right side of the abdomen; extreme distention followed; the skin overlying the right lumbar region became blue on the sixth day. One year before the patient had had an operation for appendicitis; for this reason a diagnosis of retroperitoneal suppuration due to further trouble with the appendix was made: the patient was operated upon on the twelfth day. An incision was made in the kidney region and the fatty capsule was removed; septic pneumonia followed and ten days later the right kidney was removed, it being thought that this was the starting point of the sepsis; the following day the patient died. This report lacks adequate pathological description.

Two other cases are reported by LENK as occurring in Hochenegg's clinic. The first that of a girl twenty years old, who was suddenly taken ill with violent pains in the right side of the abdomen; on the sixth day of her illness she was removed to the hospital, and it was noted that she was quite anæmic; the abdomen was distended, there was an illy-defined swelling in the right hypogastrium; urine was normal. Diagnosis of retroperitoneal abscess originating in the appendix was made, and the patient operated upon immediately. A retrocæcal tumor was incised and found to consist of coagulated blood; the cavity extended upward behind the liver. This patient died four days later with septic symptoms. The second case was a woman twenty-eight years old, who had suffered for two years with attacks of pain in the right side of the abdomen; she presented a clearly palpable tumor in the right lower region of the abdomen. Hochenegg removed the fatty capsule, in which were numerous slight hemorrhages, and subsequently demonstrated with the cystoscope and ureter catheterization a hydronephrosis of the right kidney with pronounced impairment of function. This patient left the hospital cured.

It will be noted in remembering the history of these cases of hemorrhage into the renal substance exclusive of aneurism, that with the exception of Doll's second case and the writer's there is no reference made to any communication existing between hemorrhage in the interior of the kidney and hemorrhage into the fatty capsule. In fact, in several of the cases it is noted that the kidney appeared normal (Hildebrandt, Schnitzler), and that the hemorrhage surrounded the kidney. I believe we can therefore say that we have to do with *two pathological conditions:* one arising within the kidney, and later through rupture of the capsule propria involving the tissues around the kidney; the other arising in the fatty capsule of the kidney. Either of these forms may later become so extensive as to rupture the peritoneum and involve the peritoneal cavity. Such hemorrhages as the latter are occasionally seen in fatty tissues of other parts of the body in corpulent people; they follow slight exertion, such as a sudden twist or strain on the part, and have been known to occur when the patient turned over in bed. As an example of this condition of hemorrhage into fatty tissues may be cited the case of a patient referred to me by the late Dr. J. F. Haller. This patient, an extremely stout man, had been seized with sudden pain over the region of the gall-bladder while turning over in bed; his pain and shock were so intense as to cause a diagnosis of cholelithiasis to be made; when he came under my observation some four or five days later, there was a lack of fever or of any constitutional disturbance. There was, however, a tumor in the abdominal wall overlying the gall-bladder and hepatic flexure of the colon; this mass was ovoid, about the size of the palm, and rather dense; an exploratory incision revealed it to be a rupture of several of the radicles of the epigastric veins, resulting in a hæmatoma. Healing was uneventful.

Symptomatology.—Excluding the cases of aneurism, Tuffier's case of sarcoma and Armstrong's case of congestive nephritis, there remain eight cases (Hildebrandt, Doll's two cases, Joseph, Lenk's two cases, Schnitzler and Fowler) having sufficient data to be of value. Spontaneous hemorrhage either in or about the kidney has occurred three times in males and five times in females; in four cases of young adult life, in three cases of middle age, and one case in old age. It has been associated with jaundice once, with arteriosclerosis and chronic nephritis twice, with gout once, without other diseases four times. In no case was any history of traumatism obtained. In two cases the history definitely states that the patient was fat. The onset of the attack was sudden in all cases, the character of the pain was agonizing in six cases, was less acute in two cases (Hochenegg's second case and the author's case). In all the cases the location of the pain was referred to the half of the abdomen corresponding to the kidney affected. One case gave urinary symptoms—the author's case in which there was sharp, cutting pain in the left lumbar region radiating to the front of the abdomen and down to the pelvis accompanying urination. There was also blood in the urine in this case. In three cases the urine was stated to be normal. In one case there was impairment of function of the kidney affected. In one a mild nephritis; in two a chronic nephritis; in one the urinalysis is not stated.

Shock was a prominent initial symptom in most of the cases though not definitely stated in some cases.

The final location of the pain where mentioned in the history was referred to the lumbar region. Tumor was present in all the cases, though in three it was not well defined, and in one of these latter diagnosis of the location of the swelling was further confused by a much distended gall-bladder.

Extreme abdominal distention is noted in five cases, one not noted, one with slight distention, one no distention.

Anæmia was present in four cases, not present in one case, and not noted in three cases.

Local discoloration of the skin was noted in three cases, absent in five.

Location of the tumor: On the left side below the costal arch, one case; on the left side of the abdomen, left lumbar region and left half of the scrotum, one case; left half of the abdomen and left renal region, one case; right side of the abdomen and right lumbar region, one case; right hypogastrium, one case; right lower region of the abdomen, one case; right upper side of the abdomen, one case; left renal region, one case.

Fever was present in four cases, absent in one case, not noted in three cases. Even where present it was not a prominent symptom before operation.

The symptoms vary according to the severity of the hemorrhage. The course of the attack varies from two days to twenty-six days. In the unoperated fatal cases the course of the attack was five days. There may be slight repeated hemorrhages, as in Hochenegg's second case, or more severe repeated hemorrhages, as in the author's case, extending over a period of from two to twenty years.

Diagnosis.—The diagnosis of hemorrhage into the kidney substance or into the perinephritic fat is difficult if not impossible. Of the cases which we are considering, one was diagnosed as cholecystitis; in two cases exploratory incision was made; no diagnosis in two cases; retroperitoneal abscess from appendicitis in two cases; hydronephrosis associated with calculus in one case. It is a concomitant symptom of shock or shows interference by pressure on the intestinal nerves.

Urinary symptoms are of no aid except as excluding other lesions of the kidney. In only one case was blood found in the urine.

The diagnosis, if made at all, must be made upon the occurrence of sudden pain in the renal region, associated with tumor and more or less shock, and must be supported by the exclusion of other lesions of the kidney.

Treatment.—Of the eight cases reported six were operated upon, of whom four recovered and two died, a mortality of 33⅓ per cent. The two cases not operated upon both died.

The technic of the operative treatment will depend on the pathological condition found at the operation. If bleeding is limited to the perirenal fat, this must be excised completely, the hæmatoma removed, and adequate drainage provided. If, however, the bleeding proceeds from the interior of the kidney and has later involved the perirenal fat, not only must the perirenal fat and hæmatoma be removed but a nephrectomy done as well. Thorough removal of the fatty tissues infiltrated with blood-clot is essential, as the post-operative history of these cases shows that suppuration easily follows.

REFERENCES.

Non-Traumatic Large Hemorrhage Into the Kidney or Its Surroundings.

Dickinson, W. H.: Treatise in Albuminuria, Wm. Wood & Co., 1883, p. 59. (Armstrong, Am. J. Med. Sciences, 1885, p. 454.)
Hildebrandt: Deutsch Zeitschrift f. Chirurgie, 1894, Bd. 40.
Tuffier: Bull. de la Soc. de Chir. de Paris, 1906.
Doll: Münchener med. Wchenschr., 1907, No. 49.
Joseph, H.: Deutsch Zeitschrift f. Chirurgie, 1908, Bd. 94.
Lenk, R.: Deut. Zeit. f. Chir., 1909, Bd. 102.
Fowler: Brooklyn Surg. Soc., Nov. 4, 1909. (L. I. Med. J., April, 1910.)
Pick, P.: Mediz. Klinik, 1910, No. 25.

Aneurism.

Keen: Phila. Med. Journ., May 5, 1900.
Morris: The Lancet, Oct. 6, 1900.
Skillern: J. of Am. Med. Assn., Jan. 6, 1906.
Markley: Med. Council, Phila., 1909, iv, 225.

THE OPERATIVE TREATMENT OF THE DEFORMITY OF POTT'S DISEASE.*

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THE treatment of Pott's disease after the general acceptance of the principles of mechanical support, as demonstrated by Taylor and Sayre, had become practically one of routine, when in 1897 fresh interest was aroused by Calot's advocacy of forcible correction of the deformity.

This, although an ancient practice, and although it had been performed in a fashion by Chipault several years before, was, as far as its practical application was concerned, a new operation. After a very general test it was abandoned, not so much because of its dangers as because it had been demonstrated by autopsy and confirmed by experience that the capacity for bone formation between the separated vertebral bodies was quite inadequate to fill the gap caused by straightening the spine. Thus recurrence of deformity was not only inevitable, but necessary even for repair.

Calot's operation served an important purpose in calling attention to the ineffectiveness of routine treatment, and, although forcible correction was abandoned, greater effort has been made since this time to reduce deformity by milder means and to remove pressure and friction, the most constant factors in the destructive process, by extension and hyperextension of the spine.

My own contribution has been the narrow convex frame designed to correct deformity by gravity, and to hold the spine in hyperextension during the active stage of the disease. This is, in popular speech, the "board" which the photographs of Smiling Jimmy of the Sea Breeze Hospital have made familiar.

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* Read before the New York Surgical Society, October 11, 1911

For ambulatory treatment Tunstall Taylor, Goldthwait and others devised apparatus to apply jackets in dorsal recumbency, while Calot, in his persistent efforts to reduce deformity, made a still more important modification of the plaster support. Better fixation was assured by including the shoulders, neck, and, if necessary, the head, while corrective force was provided by pressure over the kyphosis, the front being cut away to permit the protrusion of the chest as the trunk was pushed forward. Calot has presented photographs showing recession of marked deformity, and although this is unusual, it must be admitted that the Calot jacket is far more effective than ordinary supports, requiring, however, more skill in its application and more careful supervision to make it tolerable.

While it may be stated that, under favorable conditions, by the use of simple means such as the convex frame in recumbency and the Calot jacket in ambulation, deformity may be prevented and even in some degree lessened; on the other hand it must be admitted that, at best, mechanical treatment is tedious and difficult; and that it is ineffective under ordinary circumstances is evidenced by the number of noticeable deformities from this cause, the degree being determined rather by the character and situation of the disease than by the means used to prevent it.

For example, the cervical and lumbar or free regions of the spine are favorable for treatment, and, in the absence of complications, recovery without noticeable deformity may be anticipated. In the thoracic region, on the other hand, the opportunity for deformity is great, and the constant movement of the thorax in respiration makes it difficult to assure the rest essential to repair.

Repair in milder cases is sometimes accomplished by adhesion of the adjoining vertebral bodies, but ordinarily the loss of substance is so great that symmetrical apposition is impossible. In this class of cases final consolidation is sometimes assured by a callus formation, which involves the lateral masses and even the laminæ and spinous processes remote from the disease.

The object of operative treatment is to induce such consolidation of the posterior part of the spine, in order that it may serve as an effective splint to prevent deformity and to assure the rest that permits repair.

The first operation for this purpose was, it would appear, suggested by Hadra (*Trans. American Ortho. Assn.*, vol. iii, 1891). He proposed to bind the spinous processes of the diseased and adjoining healthy vertebræ to one another by silver wire twisted in figure-of-eight turns, a procedure which had been successfully employed by him in a case of fracture.

A similar and more comprehensive operation, in that deformity was first corrected and the adjacent spinous processes denuded and afterward bound to one another by silver wire, was later described by Chipault in 1893.

Recently F. Lange, observing the toleration of the tissues for silk, metal, and other foreign substances, has attempted to replace external support by internal splints, which being independent of the patient's control should be more efficient. He found tin plated steel to be the best material, and in the one successful case which he reports in detail the procedure was in brief as follows: The splints were of tin plated wire, 10 cm. long and 5 mm. in thickness. Incisions were made through the skin and fascia, corresponding to the upper and lower ends of the splints, which were then inserted beneath the muscles close to the spinous processes, on either side of the diseased vertebræ, the bulbous extremities being attached to the spinous processes by silk to retain them in position. A Calot jacket was applied with an opening to prevent pressure. This was replaced in six weeks by a celluloid corset worn constantly for six months, when, the patient being free from pain, it was gradually discontinued.

The operation was performed about two years before it was reported in 1910 (*Journal American Ortho. Assn.*, Nov., 1910). The patient was a boy about twelve years of age, the disease at about the tenth dorsal vertebra. Pain was immediately relieved and the progress of the deformity was checked. After the support was discarded the boy served as a helper to a blacksmith. The metal splints remained in position, holding the diseased section of the spine securely. Lange considered the transplantation of bone, but because of the additional injury to the patient in autoplastic transplantation and because of the difficulty of obtaining suitable material from other subjects at the proper time, he preferred to experiment with metallic supports.

Another form of operation on the lines of that of Chipault, but in a more effective form, has been described by R. A. Hibbs, the design being to induce adhesions between the spinous processes and at the same time to lessen the prominence of the kyphosis (*N. Y. Med. Jour.*, May 27, 1911). An incision is made along the spinous processes, the interspinous ligament is split and separated with the periosteum to either side. With a chisel the base of the spinous process of the sound vertebra above the diseased area is cut through, and the operation is repeated on the spinous processes involved in the disease, including finally the sound one at the base. Each spinous process is then displaced and tilted downward so that, while a part of its base is still in apposition with the surface from which it has been displaced, its tip is brought into contact with the upper part of the area from which the spinous process of the vertebra below has been separated. The tissues are then sewed over the fragments and a support is applied.

This operation was first performed on December 27, 1910, and has been repeated on two other patients. In the first case an X-ray picture taken three months after the operation shows consolidation of four spinous processes, the disease being at the second lumbar vertebra. All support had been removed on April 5 or about three months after the operation. Hibbs suggests that supplemental bone grafting from the tibia might be necessary to secure consolidation in younger subjects.

In an article appearing recently (*Jour. Amer. Med. Assn.*, Sept. 9, 1911), F. H. Albee reports three cases in which bone taken from the tibia was transplanted to one side of the spine. The spinous processes overlying the disease were split longitudinally to the lateral side of the centre. The lesser section was separated laterally, leaving a wedge-shaped interval into which the bone graft was placed. The first operation was on June 11, 1911, the last on July 14. The report was apparently made soon after, consequently no further details, except that primary union was obtained, are given.

In considering operative treatment it has seemed to me that it should be especially indicated in early cases of disease in the thoracic region, in which the deformity might be easily corrected with but slight separation of the vertebral bodies; that Lange's method was mechanically the best, but that the metal splints should be replaced by bone of sufficient strength to serve as an immediate support, and which in process of absorption might stimulate a callus formation from the neighboring parts similar to that found in the natural cure.

The patient who first offered a favorable opportunity for a test of the treatment was a boy nine years of age, who was admitted to the hospital because of a pressure sore caused by a plaster jacket. The disease was progressive as evidenced by pain, muscular spasm, and lateral distortion of the body. There was a moderate degree of angular deformity, which was sufficiently flexible as to indicate that there had been no progress toward repair.

On August 11, 1911, the ulcer over the kyphosis being closed, the operation was made as follows: The entire length of the crest of the tibia was exposed, and a thick, strong section of its anterior part, six to seven inches in length, was separated with the chisel. This retained the periosteum intact on its upper surface and the endosteum on its lower, the medullary cavity of the bone being completely exposed. The tibialis anticus muscle was drawn over the gap, the skin was sutured, and a plaster bandage was applied.

An incision about four inches long was made a little to the right of the median line over the diseased area, and the muscles were separated on either side from the spinous processes and lateral masses, the tissue was removed from between the spinous processes, and the bony surfaces in the neighborhood freshened. The tibial bone was then cut into two equal parts, and the spine having been forcibly straightened, these were inserted by the side of the spinous processes with the periosteal surface uppermost. The muscles were sewed over the grafts and the wound was closed. A Calot jacket was applied and to its contour a convex stretcher frame was adjusted.

The patient, after an uneventful period of five weeks, died six weeks after the operation, apparently of tuberculous meningitis. This complication is relatively so common in all forms of tuberculous disease in children, according to the statistics of this hospital no more so in those who have been subjected to operation than in those who have not, that it is impossible to say whether or not the treatment hastened the outcome. Unfortunately, no autopsy or even examination was permitted. All wounds were closed and the bone grafts were firmly fixed, supporting the spine in the corrected position.

In the literature of the subject but two positive observations appear: (1) that in Lange's case metal splints were tolerated for a period of two years, and that they served the purpose for which they were used; (2) that in one of the cases reported by Hibbs, ankylosis between the spinous processes of the lumbar vertebræ was secured, and that this union was sufficient to support the spine. Furthermore, it is sufficiently established that the tissues will tolerate transplanted bone, which may serve a temporary purpose as a support and, in the process of absorption, stimulate the reproduction of bone from the adjacent tissues.

Bone transplantation from the same individual is usually more successful than from other subjects. Grafts are usually taken from the tibia for obvious reasons. Possibly sections from the ribs, as suggested by Dobrotworski (*Zeits. f. Chir.*, Aug. 12, 1911), might be equally serviceable.

As has been suggested, the operation seems to be especially indicated in disease of the thoracic region in which the deformity may be easily corrected. In this class of cases the tissues are so thin that the bone splints should be buried beneath the muscles to avoid the danger of pressure necrosis.

The procedure followed by Albee does not appeal to me, as the implanted bone is too superficial and is unsymmetrically placed.

Hibb's operation, which lessens the direct deformity and which has, in the reported case, induced ankylosis, might be with advantage combined with transplantation.

At the present time operative treatment is in the experimental stage, and its actual value can be determined only by years of observation. This point of view and the exigency of this occasion will excuse the inconclusive report that has been presented.

MODIFIED AUTOGENOUS GRAFTING AND TURNING SKIN FLAPS TO COVER GRANULATING SURFACES.

REPORT OF EXTENSIVE BURN PRESENTING UNUSUAL FEATURES.

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AND
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THE case reported below, while probably not unique, presented many uncommon features. The methods employed are also not strictly original, but differ considerably from the usual methods employed in such cases. The case is not the only one which has been treated by the methods described. It has been selected from 35 cases which have been under treatment for similar conditions during the past seven years, because it illustrates especially well the value of the modifications of usual methods described.

The patient, H. E., aged twelve years, threw gasoline on a bonfire in August, 1909. His clothing caught fire and he was badly burned over the areas marked in the photograph. With the exception of scattered spots on the buttocks and arms, the burns were of the second and third degree. In a hospital near his home, some weeks after the injury, large Thiersch grafts were taken from both thighs of the patient. These grafts failed to take, and he was left with large suppurating areas on the thighs in addition to the burned surfaces. At the same hospital, a like attempt was made with grafts taken from his father with the same result. The first of January, he was brought to the Ithaca City Hospital. At that time his condition seemed hopeless. He was very thin and anæmic; appetite and digestion poor; temperature ranging above normal; so weak that he had been confined to bed for over three months. The raw areas were badly infected, discharging pus freely and covered with sluggish granulations.

Our first efforts were directed to building up the boy's health and strength by general hygienic, dietetic, and tonic measures, and to get rid of as much of the infection as possible. All the milk and eggs he could take, raw beef juice, 12 oz. a day, plenty of fresh air, nux, quinine, and iron were the general measures used. Moist weak bichloride of mercury dressings were applied locally and changed daily. Under this treatment, he gained considerably in weight and strength, the hæmoglobin percentage rose, and the granulating surface became cleaner.

Deeming him too weak to stand autogenous grafting, grafts were taken from others. Seventeen attempts of this kind were made, the grafts being taken from fifteen different individuals. In every case the grafts did well at first and remained in seemingly good condition for about three weeks, when in the course of a few days they would disappear, leaving no trace. Both Thiersch and Wolf-Krause grafts were employed with equally complete failure.

As a last resort, under local anæsthesia, long, tongue-like flaps were cut wherever possible and turned into the burned area, being left attached to normal skin by a narrow pedicle. This procedure proved entirely successful and the epithelium rapidly covered in the areas between the flaps. Flaps were turned nine times; two flaps on three occasions, only one at other operations.

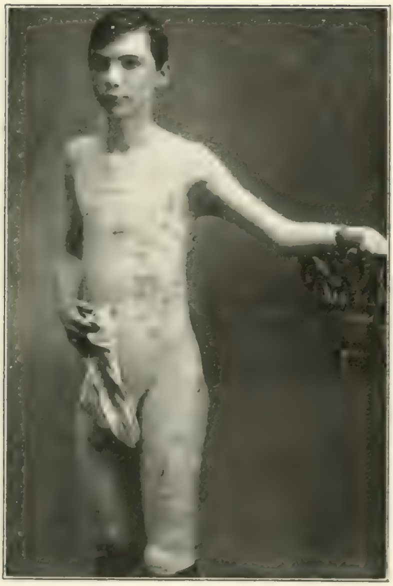
Of necessity the application of this method was limited and we now turned to small autogenous Thiersch grafts. The technic employed was as follows: Over a portion of the granulating area, the granulations were curetted away or trimmed down. Gauze moistened in 1 to 4000 adrenalin chloride solution was laid over the areas so treated. This controlled hemorrhage very satisfactorily. The area from which the grafts were to be taken was then prepared with ether and alcohol and parallel lines of infiltration with 1 : 500 novocaine solution were made. Along these lines narrow strips of Thiersch grafts were taken. These strips were cut into small pieces. The denuded area was dressed with a thick layer of sterile vaseline spread on canton flannel. Small pieces of the grafts were then applied to the raw surfaces rendered dry by the adrenalin chloride solution. They were dressed with gauze wrung out of saline solution, over which was placed oiled silk. Because of the large amount of discharge from the granulating area, the gauze was moistened every four to six hours and changed every twenty-four hours. Later on when a rather severe infection with *Bacillus pyocyaneus* occurred, the gauze was moistened with a 1 : 10,000 bichloride without perceptibly influencing the grafts or the infection. Careful and thorough cleansing of the skin about the granulating surface seemed to be the most efficient means of controlling the infection, and its influence varied directly with the conscientiousness of the individual doing the cleansing.

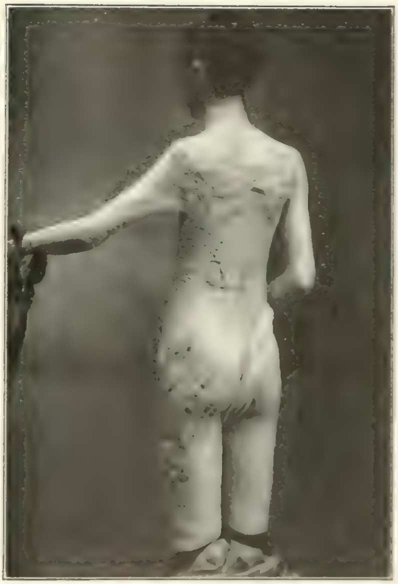
The modified Thiersch grafts managed in this way were uniformly successful and the patient left the hospital entirely healed on December 24, 1910.

In April, 1911, we decided to try to approximate the extent of the area originally uncovered by skin. Of necessity it was an approximation. The area of the scar is considerably less than that of the original denuded area. Spaces between the flaps turned in, which were at that time 2 to 2½ inches wide, are now from ½ to ¾ of an inch wide. Any one with much experience in burn cases realizes the extent to which contraction takes place.

The scarred areas were divided into approximate parallelograms and triangles and the surfaces estimated in that way. The figures thus obtained were 3075 square centimetres (about 500 square inches).

The total skin area of the human body is variously estimated. Vacher gives 10,500 to 15,000 sq. cm.; Wilmart, 16,400 to 18,700; Lefevre, 14,500 to 15,000; Bordier, 16,717 to 19,445 for men 5 ft. 9 inches in height. Sappey, working with six average sized adult men, puts the figures at 15,000 sq. cm.; the average adult woman, 11,500 sq. cm. The boy in this case was twelve years old at the time of his accident, a little over 5 feet tall and weighed between 70 and 80 pounds. At the time he left the hospital in December, 1910, he weighed 98 pounds. Considering his size as related to that of the average adult male, it would seem that 9000 sq. cm. would be a high figure for his skin area.





With a scar measuring about 3075 sq. cm. it seems certain that in this case there was well over one-third of the body area denuded of skin at one time.

This case has seemed to us and many other physicians who followed the progress of the boy to be of unusual interest for many reasons.

The denuded surface was unusually large to be followed by recovery. The older text-books all estimate that a burn involving more than one-third of the body surface is almost sure to be fatal. The careful estimates given above show that this area was very much exceeded in this case.

A second point of great interest and value was the complete failure to get any results from heterogeneous grafts. In many cases of skin grafting, heterogeneous grafts taken from one person will fail, while those taken from another will "take" successfully. In this case, 17 attempts were made with heterogeneous grafts taken from 15 different persons and with ultimate failure in every instance. Of further interest in this connection is the fact that primarily every one of these attempts promised to be successful. Almost all of the grafts adhered well, and in most cases seemed to be spreading and covering in the raw surface nicely. The improvement would continue for about two and a half to three weeks. In several cases, the grafted surfaces seemed to be entirely and permanently covered in with the heterogeneous grafts and the epithelium which spread over the raw edges. But at the end of about three weeks, the grafts began to fade slowly and apparently dissolve away like ice in water, again leaving a raw surface. The results for the first two or three weeks were in every case encouraging. The disappearance of the grafted skin is probably caused by a process similar to hæmolysis. The grafts and epithelium disappeared in the same way that the blood-corpuscles disappear in many cases of blood transfusion. A further study of this condition would seem to be desirable and to promise much of scientific interest.

A third point demonstrated to our satisfaction in this and in a number of other cases is that it is unnecessary to scrape off the granulation tissue in preparing the surface for grafting. The granulations need be simply trimmed down a little with scissors curved on the flat. This gives very much less bleeding than entirely to scrape away the granulations as was tried on several occasions. The results were as good when the granulations were simply trimmed as when they were entirely scraped away.

A fourth point which has been mentioned by other observers is that the autogenous grafts do well in spite of infection. The attempts to get rid of infection in this case have been already mentioned.

A fifth point that we have not seen mentioned in this connection is the use of a gauze sponge saturated with diluted adrenalin chloride solution applied immediately to the freshened surfaces to arrest oozing. In this way a very considerable amount of blood was saved.

Sixth, we would again call attention to the fact that both the thin Thiersch grafts and the full thickness Wolf-Krause heterogeneous grafts were unsuccessful.

Seventh, an unusual feature deserving emphasis, it seems to us, was the turning in of flaps to cover the raw surfaces. The advantages of turning in flaps were several: (1) It did not create any further raw surfaces; (2) there was much less loss of blood than when a surface of any considerable size was grafted. Both of these points were matters of great importance in the case of a boy so weakened, anæmic, and septic. (3) Such flaps proved certain to grow if properly used. (4) Ultimate results were much better than if grafts alone had been employed. The peninsulas of normal skin formed by turning in flaps give less scar-tissue contraction, for these strips of normal skin soon become naturally elastic and also have normal sensation.

Of great importance seems to us the use of local anæsthesia. In this case it seems highly improbable that the boy could have recovered had general anæsthesia been given to him repeatedly for small operations, and he almost certainly would not have recovered had an attempt been made to cover the entire surface or any large portion of it by one operation at first.

There are undoubtedly many less serious cases of burn or injury in which a similar procedure would be advantageous. Very many patients come through a long and tedious convalescence, attended by much pain and considerable risk to life from septic poisoning, who could be promptly healed by this method of skin grafting under local anæsthesia with or without turning flaps as described. The conclusions given have been reached after a good deal of experience in handling 35 cases of this kind. The case described was selected as a text simply for the reason that the conditions illustrate especially well the difficulties usually met in such cases and a possible successful solution of the problem.

A NEW CONTAINER FOR STERILIZED OPERATING SUPPLIES.

BY KARL CONNELL, M.D.,
OF NEW YORK.

Instructor in Surgery in the College of Physicians and Surgeons, Columbia University,
Second Assisting Surgeon, Roosevelt Hospital.

EVERY device that simplifies the handling of the operating room supplies is a step toward absolute asepsis as well as toward economy of energy. The new container here described is such a device, and since it is adapted to a single operation it has been called the "unit shell." It consists of a large longitudinally split cylinder assembling in one receptacle the dry goods needed for one operation, easily packed, and effectively sterilized and stored. It is simple, convenient, and time saving in the operating room.

The day of the many small package system in hospital practice passed when it became possible to sterilize large bundles by vacuum exhaustion and steam under pressure. This advance simplified the technic. Preparing and opening a few cloth- or paper-covered bundles was found quicker and safer than handling many.

The next step in advance was the use of a large drum-shaped metallic container. This drum was more economical of space in the sterilizer, less exposed to contamination during storage, and more readily accessible to the clean operating room attendant than any package hitherto devised. The best types were of copper, with holes in the side which were open during sterilization and closed immediately thereafter by a sliding band. These were designed to stand on a skeleton frame in the operating room with an arm to engage the lid and open the same when desired, by a foot pedal. Usually a full operating room equipment was contained in three or four drums. Into these the nurse plunged for supplies with sterile forceps. This type of container has been widely accepted, and is a great step toward asepsis and economy of energy.

The defects in this type, as met with in the writer's observation of hospital work, are partly mechanical. The sliding bands become dented and jammed, the lid loosened, the single hinge bent, and the closure untrue. The holes are many, and closure of all holes is frequently not effectual; either the sliding band is defective or else the contents get jammed in a hole and become contaminated unobserved. Also machinery is needed to operate the lid, a lever, a foot pad, and counterweights. As the foot pedal requires a strained posture on the part of the nurse, it wastes time when the saving of an instant may be important. Also, if the unused contents are to be carried over to a succeeding operation, they must be handled only by sterile forceps, another waste of time and energy. Most important, the contents are subject to contact-infection from one case to the next through accidental use of unclean forceps and hands in stress of emergency, and many surgeons, realizing this danger, assign the most highly trained operating room nurse to attend the pedalling and doling out of the clean goods, thereby losing her from the operative field.

To preserve the advantages and to obviate the defects of the present metallic containers, the writer devised for the Roosevelt Hospital the new type of container now to be described. It has been tried out under adverse conditions, night emergency cases, and shifting nursing corps, etc., and has been found to meet every requirement.

The container as shown in the diagram (Fig. 1) consists of a longitudinally split copper shell, opening along the back on a strong rolling or piano hinge, into two equal halves, making when open a flat table, as it were. It closes by a single overlapping engaging joint, into a dust-proof cylinder of appropriate size to fit a sterilizer. For a 16 inch sterilizer it is 14¾ inches in diameter over all, and is 18 inches long.

The shell is planned to carry an excess of all the operating supplies required at any operation, towels, all sizes of wipes, pads, dressings, cotton and bandages, glassware, safety pins and drainage tubes, rubber goods, etc., as experience dictates sufficient for any extensive operation—in fact, everything except dishes, instruments, suture material, and surgeon's attire. The routine of packing is indicated by written schedule, so as to properly apportion the amount of contents and to place them where they can be found conveniently. The goods of each half are enveloped in a thin muslin cover, which can be thrown back to drape the edge of the opened shell, are covered by a towel, and are held in place by a detachable wire mesh cover.

The shell is then partly closed and so clasped as to leave open a half-inch slit, and is subjected to the usual sterilization (Fig. 2). Steam penetration is very effectual, since an entire slit is open instead of a few small holes as in a drum, and the steam has direct access to the deep interior of the package. The exposed surface to steam and to drying in the unit shell is 504 square inches, against about 12 square inches in the old type of drum.

Immediately after the completion of sterilization and drying, the shell is taken out, the clasps are closed, sealing the contents, lock pins are inserted, and the shell is stored for use.

The advantages to be noted thus far are, a durable shell with few working parts not readily to be damaged by mishandling, a strong rolling hinge, and overlapping engaging joint ensuring accurate closure, also effective exposure to steaming and drying in the sterilizer, and a dust proof and locked closure of the single joint of the container during storage.

When to be used, the shell is placed on a stand by a non-sterile attendant, and opened flat, making a table 18 inches by 28 inches (Fig. 3). The two wire meshes are removed by a sterile attendant, the muslin covering thrown back, draping the sides of the table and exposing the towel covered contents, accessibly arranged. This entire procedure consumes only thirty seconds, and in addition to being a great economy of time and energy, eliminates possible oversight in laying out necessary supplies and the danger of contact-infection which

Fig. 1.

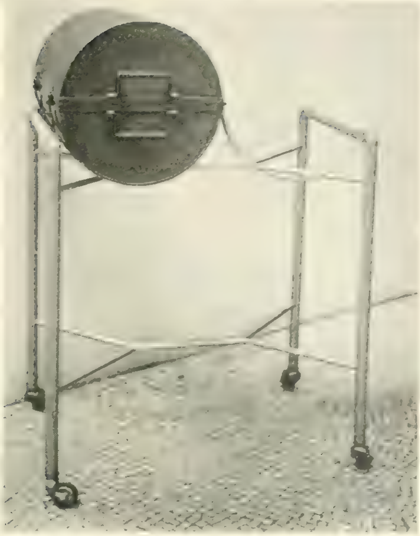


Fig. 2.

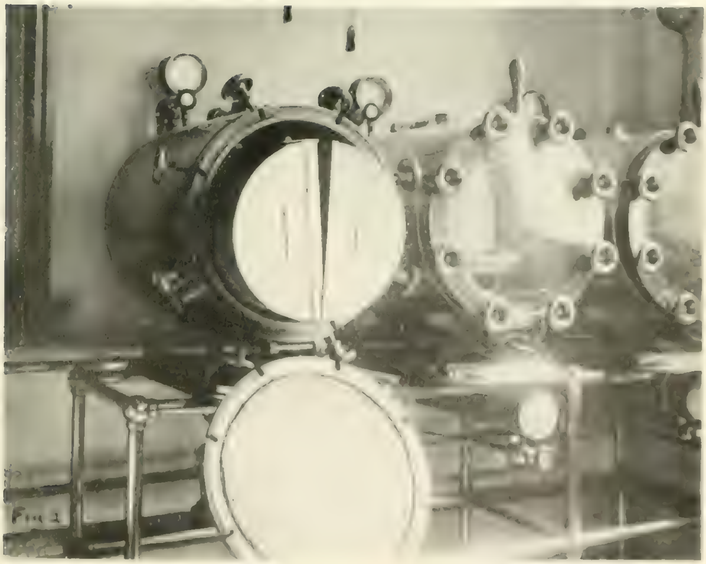


FIG. 3.

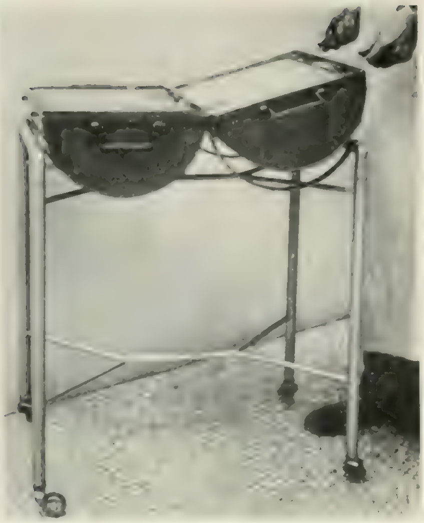
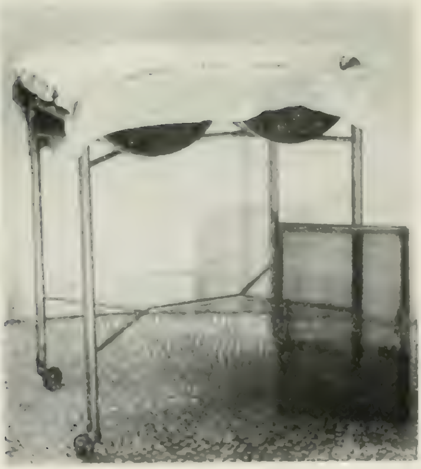


FIG. 4.



attends the opening of each package in the multiple package system. The most skilled nurse need not be assigned to handling supplies, as is the case with the present drum method, for none of the excess contents will be used on the next case and the goods are well protected against extraneous contact-infection.

Much waste motion of the drum system is saved by the use of the hand instead of the forceps, and by elimination of the pedal and machinery. This saving totals in the shell system five seconds on the average for each article secured, as over the drum method under like conditions. The goods are also accessible over a wider area, 504 square inches in the open shell against 308 inches in two opened drums of the same total capacity, thus rendering the individual objects more readily found in the shell system.

At the completion of the surgical operation the shell is closed and removed from the operating room and a fresh shell placed for the next operation. The used shell can be removed and a new clean equipment of goods opened and accessibly arranged for the next operation in less than one minute.

After removal from the operating room, the shell may be replenished from stock within a few minutes and is ready to be sterilized for future use.

While the capacity of the container is limited, the apparent inelasticity of the contents is minimized by experience in packing. An excess of those goods which may meet an unusual demand is packed as a routine. Nor does this excess mean any waste in material or in labor, for it remains in the shell and is merely added to in repacking. Rubber drainage tubes and such perishable goods are renewed when deteriorated, or about every tenth sterilization, providing they have lain unused so long. The remaining cotton goods are moved toward the top in repacking, so as to become browned by many resterilizations. Occasionally, however, goods will run short in some extensive operation and a new unit must be opened. This is as quickly done as opening a small package. Minor operations may be handled by packing each half of certain shells as a separate unit, opening one side as required for each operation.

The advantage from a stand-point of asepsis of a fresh unit for each case is so apparent as to need no comment.

In conclusion the "unit shell" offers a mechanically strong, dust-proof container, more effectively exposed to steam and to drying than any metallic container hitherto devised. It is capacious, simple, and safe in handling, is time-saving in preparing for and during an operation, and ensures in the simplest and speediest manner a clean, new equipment for each succeeding case in the stress of a busy clinic.

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY.

Stated Meeting, Held at the Hospital for Ruptured and Crippled, October 11, 1911.

The President, DR. CHARLES L. GIBSON, in the Chair.

FRACTURE OF THE NECK OF THE FEMUR TREATED BY THE ABDUCTION METHOD.

DR. ROYAL WHITMAN presented several patients who had been treated by the abduction method for fracture of the neck of the femur. The cases illustrated the two types of fracture of early life: first, at the epiphyseal junction, which was most common during adolescence in weak and over-weighted subjects. The injury was often slight, and as the process of separation was frequently gradual, the patients, usually, were not brought for treatment until months later, then for supposed disease.

In recent cases the displacement might be reduced by abduction and inward rotation, but if the fragments were adherent, an open operation was required in order that they might be separated and replaced in normal position.

In the second class of cases the fracture was similar to that in the adult, and was caused by direct violence. In all of the cases a functional cure had been obtained.

Dr. Whitman also presented a woman, seventy-four years of age, who had been treated by the abduction method for intracapsular fracture. The bone had united without appreciable deformity, as demonstrated by an X-ray picture. The patient was able to walk with ease, although a slight limp persisted. This type of fracture directly involved the joint in the injury, as well as in the process of repair, and although perfect function might be restored in favorable cases, it could hardly be expected in aged subjects.

Dr. Whitman said the abduction method was a means of applying surgical principles, namely, reduction of deformity and fixation of the fragments—principles that had heretofore been disregarded in the treatment of this type of fracture.

THE OPERATIVE TREATMENT OF PARALYTIC CALCANEUS.

DR. WHITMAN showed a number of cases illustrating this condition. In deformity of this type, in which the resistance was lost by paralysis of the calf muscle, the foot atrophied, the gait was insecure, and the distortion was progressive.

The design of the treatment was to substitute the stability of bony contact for muscular tension. The astragalus, the centre of anteroposterior and lateral distortion, was removed through an external incision. The foot was then displaced backward so that the tibia was brought into direct contact with the navicular. If the peronei muscles were active, they were transplanted into the tendo Achillis. Cavus was then reduced, lateral deformity was prevented by the malleoli which clasped the foot at its base, dorsal flexion was prevented by contact of the tarsus and the tibia, and a useful foot, which would support weight without the aid of apparatus, was assured.

This same procedure, Dr. Whitman said, was of service in cases of complete paralysis, the so-called dangle foot, and might be substituted with advantage for arthrodesis. One case of this kind was shown, the operation having been performed on both feet. The patient walked well without support, and there had been a very appreciable restoration of muscular power, which had before been latent.

ARTHROPLASTY FOR BONY ANKYLOSIS.

DR. WHITMAN showed three of these cases. The first patient was a woman suffering from chronic polyarthritis of the atrophic type. The left elbow was exposed by a posterior cross incision, and the upper half of the olecranon was removed. The lower extremity of the humerus was removed in a curved line, with the convexity uppermost; the remainder of the olecranon was then hollowed out to a thin shell of cortical substance, and the head of the radius was cut away, leaving a wide interval between the opposing surfaces, over which fascia was sewn. The triceps tendon was then stitched with silk to the upper end of the olecranon.

A similar operation to this was performed on the second patient, a boy nine years of age, for ankylosis following scarlet fever. Both operations had been done within a few weeks, and passive movement was to be deferred until a sufficient time had elapsed to permit repair of the denuded surfaces. It was thought that the wide interval between the bones would effectually prevent union.

The third case was one of ankylosis of the wrist with flexion deformity following infectious arthritis. In this instance a section representing the first row of carpal bones was removed, and the deformity corrected. This operation was done two weeks ago.

EPIPHYSEAL FRACTURE AT THE UPPER EXTREMITY OF THE HUMERUS.

Dr. Whitman showed this case to illustrate a perfect functional cure of epiphyseal fracture and displacement of the upper extremity of the humerus. The patient was a boy, eighteen years old, who had been treated six years before. The treatment was an adaptation of the abduction method used so successfully for fracture at the hip-joint, the principle being to adjust the long fragment to the small and uncontrollable fragment. The displacement was first reduced by abduction and rotation of the humerus. The fragments were then held in apposition by fixing the arm in abduction, with sufficient forward inclination, by a shoulder plaster spica, either in right angular abduction or by elevating the arm to a nearly perpendicular attitude. The method was also of service in the treatment of other fractures in the vicinity of the joint.

THE SHOULDER PLASTER SPICA.

This was illustrated by a patient who had been treated by open operation for fracture at the elbow. It was very serviceable whenever it was necessary to hold the arm in an extended position because of lateral deformity at the elbow. The entire limb, to the extremity of the fingers, was inclosed in the plaster bandage, which included the shoulder and the thorax, holding the limb in an elevated position and thus preventing the congestion and œdema that the extended attitude induced when the arm was dependent.

THE TREATMENT OF DISEASE OF THE HIP-JOINT BY ARTHRODESIS.

The patient was a woman who was admitted to the hospital for deformity and pain, which had persisted for more than a year. Her symptoms were caused, apparently, by an infectious arthritis. She had been previously treated for sciatica.

The joint was opened through an anterior incision and the upper third of the head of the femur was removed, together with a section of the upper part of the acetabulum, after the method suggested by Dr. Albee. The limb was then fixed in extension and abduction. According to Albee's diagram, the denuded surfaces were brought together by abduction, but if the joint was, as in this class of cases, fairly normal, no such contact was possible, and as in this instance, the interval must be filled by new bone formation to assure ankylosis.

BACKWARD DISLOCATION AT ELBOW.

This patient, a boy nine years old, had been treated for several weeks before admission to the hospital for supposed fracture. The joint was opened by a posterior incision and the dislocation was reduced. The operation was done three weeks ago, and perfect function was expected.

EXTREME TALIPES EQUINO VARUS.

The patient, a boy, nineteen years of age, came under Dr. Whitman's observation six months ago for a deformity which had been caused in early childhood by a cut with an axe which had severed the dorsal flexors of the foot.

At the first operation, the varus had been overcome by wrenching, and the contraction of the toes by tenotomy of the flexor tendons. Three months later, the equinus was overcome by force and by division of the tendo Achillis. The correction had been aided by constant use of the foot, which had been fixed in plaster during the treatment, and the patient had lost but two days' work in the interval. He now wore an ordinary shoe and walked without a limp. The long disused muscles were rapidly recovering functional ability.

A METHOD OF CORRECTING FIXED SCOLIOSIS.

A number of patients were shown by Dr. Whitman to illustrate this method, which was devised by Dr. E. G. Abbott, of Portland, Me. In the treatment of other deformities it was generally recognized that correction and over-correction was the first essential, after which the improved position might be retained by increasing the muscular strength and control.

In this deformity the attempt had usually been made to train the muscles with the aim of correcting or lessening the distortion, or to apply braces to prevent an increase of the deformity already present. Correction, forcible or otherwise, had been attempted while the spine was extended or even hyperextended. The essential difference of the Abbott method was to flex the spine in order to remove all tension before attempting to correct the lateral deformity and the rotation incidental to it.

The patient was placed upon the back in a narrow hammock in a rectangular frame of gas pipe, provided with an adjustable extension for increasing the forward flexion of the body. The trunk was then drawn laterally and twisted in the reverse direction of the curvature, and a plaster support was applied. Later, a large opening was made over the flattened side of the chest to permit expansion under the influence of forced inspiration. The treatment was repeated at intervals, until, if possible, over-correction was attained.

The immediate results in the cases under treatment encouraged the hope that this was a practicable method of overcoming deformity in this intractable class of cases.

FRACTURE OF THE HIP TREATED BY THE ABDUCTION METHOD.

DR JOHN B. WALKER presented a woman, twenty-six years old, who slipped and fell, fracturing the neck of the femur.. On the following day a long side splint was applied without extension. With this she was confined in bed for twelve weeks. She left the hospital on crutches and was obliged to continue their use during the following eighteen months, for no union was present. Two years after the original accident she entered Bellevue Hospital. When standing with the aid of crutches the left lower extremity hung apparently helpless; the glutei and other muscles of this thigh were moderately atrophied. Measurements showed 6 cm. shortening, confirmed by a radiograph, which showed the great trochanter to be displaced far upward.

Treatment was at once begun by applying a Buck's extension with fifteen pounds weight in order to reduce the shortening if possible. The weights were very gradually increased up to forty-five pounds. At the end of six weeks the continuous traction had diminished the shortening to 3 cm. An operation was now performed to bring the separated fragments together and secure them in apposition.

An incision beginning 2 cm. below the left anterior superior spine was extended downward and backward to the posterior margin of the trochanter and then vertically down the thigh, the soft tissues were divided, the capsule exposed and divided, exposing the fracture which had occurred, roughly, transversely through the femoral neck, the proximal fragment consisting of the upper third of the femoral head. Considerable callus was removed, and the fractured surfaces were freshened by the rongeur. By traction and abduction the freshened fragments were brought together with great difficulty.

A steel drill was passed through the great trochanter, the neck, the head, and into the wall of the acetabulum, thus spiking the fragments firmly together. The wound was closed with a small rubber tissue drain. A plaster spica was applied from the lower border of the ribs to the toes.

The wound healed uneventfully; the patient was confined to bed for eight weeks. Four weeks later a Thomas hip splint was applied and she went about on crutches, discontinuing the splint at the end of one year. Five months after the operation, the drill, which was loose, was easily removed by small forceps.

Two years after the operation there is some motion at the hip. Less than 2 cm. of shortening exists. She walks without a cane, is free from pain, and is supporting herself by doing regular work.

THE OPERATIVE TREATMENT OF THE DEFORMITY OF POTT'S DISEASE.

Dr. Royal Whitman read a paper with the above title, for which see page 841.

INDEX TO VOLUME LIV.

A

Abbe, R. W.: Excision of the Rectum and Vagina for Cancer, 234; Cure of Enormous Goitre with Radium, 235; Resection of Colon for Cancer, 236; Sarcoma of Parotid Cured with Radium, 236; Large Primary Carcinoma of the Liver Treated with Radium, 236; Angioma of the Face Treated with Radium, 237; Hypertrophy of One-half of the Tongue Treated with Radium, 238.

Abdomen, Penetrating Wounds of, 164; Stab Wound of, Evisceration through, 279.

Abdominal Wall, Anterior, Nerve Supply of, 153.

Actinomycosis, 130.

Adenoma, Malignant Papillary, of the Kidney, 585.

Adhesions, Peritoneal, Studies on, 758.

Air and Ether, Experiences in Thoracic Surgery under Anæsthesia by the Intratracheal Insufflation of, 749.

Albee's Operation for Hypertrophic Arthritis of the Hip, 265.

Allis, Oscar H.: Everted Dorsal Dislocations of the Hip, 371, 410.

American Surgical Association, Transactions of the, for 1911, 402.

Amputation of Leg by the Method of Bunge, 124.

Anatomical and Surgical Study of Fractures of the Lower End of the Humerus, by Astley P. C. Ashhurst, Review of, 142.

Anæsthesia by Chloroform, 416; Experiences in Thoracic Surgery under, by the Intratracheal Insufflation of Air and Ether, 749; Intermittent Ether, Fatalities Caused by, 418; by Intratracheal Insufflation, 417, 572.

Anæsthetic, Choice of the, 415.

Anæsthetics, the Use of Rebreathing in the Administration of, 416.

Anal Fistula, Surgical Treatment of, without Mutilation of the Sphincter, 361, 415.

Anastomosis, Arterial, the Technic of End-to-End, 485; Lateral Vascular, 496; Mechanical Aids to Hollow Visceral, 500.

Andrews, E. Wyllis: Operative Cure of Internal Hydrocephalus, 411.

Aneurism of Abdominal Aorta, Treatment of, by Partial Occlusion with Metallic Band, 30.

Ankylosis, Bony, Arthroplasty for, 860.

Anus, Rectum and Sigmoid, Diseases of, by Samuel T. Earle, Review of, 430.

Aorta, Aneurism of Abdominal, Treatment of, by Partial Occlusion with Metallic Band, 30.

Appendectomy, Followed by Right Inguinal Hernia, 673.

Appendicitis, Gangrenous, 271.

Appendix, Carcinoma of the, 277; Giant, 573.

Approximation of the Ends of Fragments in Fractures with Contraction of the Attached Muscles, 227.

Arterial Anastomosis, Needles for, 720; the Technic of End to End, 485.

Arteriovenous Anastomosis for Gangrene of the Leg, 424.

Artery, Ligation of First Portion of Left Subclavian, 503.

Arthrodesis, Treatment of Disease of Hip-Joint by, 862.

Ashhurst, Astley P. C.: Actinomycosis, 133; Amputation of the Leg by the Method of Bunge, 124; Congenital Elevation of Left Scapula, 126; Excision of Urethra, with End-to-End Suture, 128; Osteotomy of Radius, 130.

Asphyxia, Traumatic, 267.

Aspirating Cup Used as a Tractor, 271.

Atlas, Fracture-Dislocation of the, 677; Subluxation of the, 20.

B

Bartlett, Willard: A Simplified Gastro-Enterostomy Clamp, 174.

Beer, Edwin: The Treatment of Tumors in the Urinary Bladder with the Oudin High-Frequency Current, 208.

Bernheim, Bertram M.: Lateral Vascular Anastomosis, 496.

Bevan, Arthur Dean: Open Treatment of Fractures, 408.

Bismuth Paste in Chronic Suppurations, by Emil G. Beck, Review of, 429.

Bladder, Extensive Carcinoma of the, Intraperitoneal, Operation for, 593; Urinary, Polyp of, in an Infant, 589; Urinary, Treatment of Tumors of, with Oudin High-Frequency Current, 208.

Bleeding in Operation for Brain Tumors, the Control of, 1.

Bones, Fractures of the Long, 289.

Boothby, Walter M.: The Technic of End-to-End Arterial Anastomosis, 485.

Brain, Tumor of the, Treated by Decompression, 268; Tumors, the Control of Bleeding in Operation for, 1.

Branch, J. R. Bromwell: Note on Penetrating Wounds of the Abdomen, 164.

Breast Carcinoma, Multiple Diffused Metastases Following, 134; Fibro-Epithelial Tumors of, 517.

Brewer, George E.: Operative Cure in Internal Hydrocephalus, 412; Suppuration in One-half of a Horseshoe Kidney, 413.

Bristow, Algernon T.: A Study of the Infections, 433; Open Treatment of Fractures, 407.

Bunge's Method of Leg Amputation, 124.

Burke, Joseph: Early Diagnosis of Carcinoma of the Colon, 818.

C

Calcaneus, Paralytic, Operative Treatment of, 860.

Cancer, Far Advanced, Treatment of, 297.

Cancer and Induced Cell-Reproduction, by Hugh C. Ross, Review of, 713.

Carcinoma of the Colon, Early Diagnosis of, 818; Mastitoides, a Study of, 69.

Carson, F. L.: Fracture-Dislocation of the Atlas, 677.

Cartilage, Semilunar, Fracture of the Internal, 274.

Castle, H. Edward: Obesity and Its Surgical Treatment by Lipectomy, 706.

Cates, Benjamin B.: Muscle Grafting for Gunshot Wound of Shoulder, 679.

Catgut Sterilization, Note on, 693.

Chest, Stab Wound of, 281.

Childhood and Infancy, the Diseases of, by Henry Koplik, Review of, 140.

Childhood, the Surgery of, Including Orthopædic Surgery, by De-Forrest Willard, Review of, 141.

Chloroform Anæsthesia, 416.

Cholecystitis, Suppurative, 273.

Clamps, External, in the Treatment of Fractures of the Tibia and other Bones, 381, 406.

Colitis and Pericolitis, Chronic, 325.

Colon, Early Diagnosis of Carcinoma of the, 818; Lipoma of, Causing Intussusception, 344; Perforating Ulcer of the, 277.

Connell, Karl: A New Container for Sterilized Operating Supplies, 854.

Container, New, for Sterilized Operating Supplies, 854.

Coombe, Russell: Congenital Hypertrophic Stenosis of the Pylorus, 167.

Cope, Zachary V.: Impacted Fractures Through and Near the Femoral Neck, 682.

Cotton, Frederic J.: Acute Hæmatogenous Infection of the Kidney, 577.

Crile, George W.: Relaxation of Muscles in the Reduction of Dislocations, 410.

Cushing, Harvey: The Control of Bleeding in Operations for Brain Tumors, 1.

Cystoscopy, Practical, by Paul M. Pilcher, Review of, 716.

D

Da Costa, J. Chalmers: Actinomycosis, 130.

Darrach, William: Albee's Operation for Hypertrophic Arthritis of the Hip, 265.

Daugherty, Louis E.: Gastric Atony as a Cause of Neurasthenia, 306, 426.

Davis, John Staige: The Transplantation of Free Flaps of Fascia, 734.

Deane, R. B.: Simple Fracture of the Pisiform Bone, 229.

Diagnostic and Therapeutic Technic, by Albert S. Morrow, Review of, 713.

Diaphragmatic Hernia, Intercostal, 538.

Diseases, Acute Surgical, Value of the Leucocyte Count in, 721; of the Anus, Rectum, and Sigmoid, by Samuel T. Earle, Review of, 430; of the Pancreas, by Eugene L. Opie, Review of, 430.

Dislocations of the Hip, Everted Dorsal, 371, 410; Relaxation of Muscles in the Reduction of, 410.

Dowd, Charles N.: Cysts of the Omentum, 617; Remarks Upon Anæsthesia, 421.

Duodenal Ulcer, Perforating, 243.

Duodenum and Stomach, Ulcer of the, with Special Reference to the End Results, 313, 427.

E

Eberts, von, E. M.: Negative Tension Drainage in the Treatment of Empyema, 58.

Ectopic Gestation with Lithopedion, 251.

Ehrenfried, Albert: Needles for Arterial Anastomosis, 720; The Technic of End-to-End Arterial Anastomosis, 485.

Elbow, Backward Dislocation at, 862; Tuberculous Arthritis of the, 278.

Elsberg, Charles A.: Anæsthesia by Intratracheal Insufflation of Air and Ether, 572; Experiences in Thoracic Surgery under Anæsthesia by the Intratracheal Insufflation of Air and Ether, 749.

Ely, Leonard W.: Subluxation of the Atlas, 20.

Empyema, Negative Tension Drainage in the Treatment of, 58.

Encephalocele, Frontal, 283.

Epigastric Hernia, 78.

Episcopal Hospital of Philadelphia, Surgical Clinic of the, 554.

Epispadias in the Female, its Surgical Treatment, 402.
Ether Anæsthesia, Fatalities Caused by Intermittent Administration, 418.
Extremities, Lacerated and Incised Wounds of, Treatment of, 696.

F

Fascia, Transplantation of Free Flaps of, 734.
Femur, Fracture of the, Complicated with Dislocation of Hip, 393; Fracture of the Neck of, Treated by Abduction Method, 859; Fracture of, Operative Treatment, 260; Impacted Fractures Through and Near Neck of, 682; Supracondyloid Fracture of, Treated by Plating, 257.
Fibro-Epithelial Tumors of the Mammary Gland, 517.
Fistula in Ano, Surgical Treatment of, Without Mutilation of the Sphincter, 360, 415; Vesicovaginal, from Penetration of Floor of the Bladder by Horn of a Bull, 287.
Foote, Edward M.: Pyloric Adhesions Freed by Operation, 262.
Forearm, Fracture of the, Treated by Wiring, 277.
Fowler, Russell Story: Non-Traumatic Large Hemorrhage into the Kidney Substance or its Surroundings, 831.
Fractures of the Long Bones, the Treatment of, 289; Open Treatment of, 404, 576; Treated by Wiring or Plates, 255, 256, 260; Treatment of, by External Clamps, 381, 406; Treatment of, by Charles L. Scudder, Review of, 719; with Contraction of the Attached Muscles, Approximation of the Ends of Fragments in, 227.
Frazier, Charles H.: Actinomycosis, 132; Anæsthesia by Intratracheal Insufflation, 572; Operative Cure in Internal Hydrocephalus, 412; Surgical Clinic of the Protestant Episcopal Hospital of Philadelphia, 554.
Freeman, Leonard: Anæsthetics in Tuberculosis, 420; The Treatment of Oblique Fractures of the Tibia and Other Bones by Means of External Clamps, 381, 406.

G

Gall-Bladder and Bile-Ducts, Some Modifications of Technic in the Surgery of, 110; and Bile-Ducts, Technic in the Surgery of, 428; Double, Removed by Operation, 204.
Gall-Stone Ileus, 321.
Gall-Stones, Case of Operation for Stone in the Common Duct, 249; the Pathology and Symptomatology of, 83, 176.
Gastric Atony, a Cause of Neurasthenia, 306, 426; and Duodenal Ulcer, 806; Ulcer, Perforating, Operation for, Followed Two Years Later by Gastrojejunostomy, 278.
Gastro-Enterostomy, a Simplified Clamp for, 174.
Gastroscopic Examinations, 567.
Gatch, Willis D.: Rebreathing in the Administration of Anæsthetics, 416; Treatment of Aneurism of Abdominal Aorta by Partial Occlusion with Metallic Band, 30.
Gerster, Arpad G.: On Chronic Colitis and Pericolitis, 325; Open Treatment of Fractures, 409; Regarding General Anæsthesia, 422.
Gerster, John C. A.: Intercostal Diaphragmatic Hernia, 538.
Gibbon, John H.: The Treatment of Far-Advanced Malignant Disease, 297.

Grafting, Modified Autogenous, and Turning Skin Flaps to Cover Granulating Surfaces, 848.

Green, Nathan W.: The Management of Post-Operative Thoracic Infections, 549, 568.

Greenough, Robert B.: Fibro-Epithelial Tumors of the Mammary Gland, 517.

H

Halstead, Albert E.: Arteriovenous Anastomosis for Gangrene of the Leg, 424; Extirpation of Tumors of Vomer, 424.

Hammond, Levi J.: Considerations Relating to the Pathogenesis and Diagnosis of Surgical Diseases of the Pancreas, 798.

Harris, Malcolm L.: Conservatism in Operating on Horseshoe Kidney, 414; Open Treatment of Fractures, 409.

Harte, Richard H.: Some Considerations in the Treatment of Fractures of the Long Bones, 289.

Hemorrhage, Non-Traumatic Large, into Kidney Substance or Surroundings, 831.

Henderson, Yandell: Fatalities Caused by Intermittent Ether Anæsthesia, 418.

Hernia, Artificial, 265; of Descending Colon, Sliding, 265; Double Inguinal, Associated with Tuberculous Peritonitis, 264; Epigastric, 78; Femoral, Strangulated Prevascular, 265; Inguinal, Treated by Paraffin Injection, 286; Inguino-Superficial, Strangulated, 264; Intercostal Diaphragmatic, 538; Right Inguinal, following Appendectomy, 673; Strangulated in Young Infant, 262.

Hewitt, Herbert W.: The Value of the Leucocyte Count in Acute Surgical Diseases, 721.

Hewson, Addinell: Multiple Diffused Metastases following Breast Carcinoma, 134; Plastic Restoration of the Lower Lip, 133; Results after Removal of Advanced Cancer of Lower Jaw, 570.

Hip, Dislocation of the, Complicated with Fractures of the Femur, 393; Everted Dorsal Dislocations of the, 371, 410; Fracture of, Treated by the Abduction Method, 863; Hypertrophic Arthritis Treated by Arthrodesis, 265; Irreducible Dislocation of, Treatment, 410.

Hoguet, J. P.: The Nerve Supply of the Anterior Abdominal Wall, 153; Right Inguinal Hernia following Appendectomy, 673.

Horseshoe Kidney, Suppuration in Half of, 355, 413.

Hotchkiss, Lucius W.: Epigastric Hernia, 78; Fracture of the Internal Semilunar Cartilage, 274; Giant-Celled Sarcoma of the Tibia, Treated by Enucleation, 272; Suppurative Cholecystitis, 273.

Humerus, An Anatomical and Surgical Study of Fractures of the Lower End of the, by Astley P. C. Ashhurst, Review of, 142; Epiphyseal Fracture at Upper Extremity of, 861.

Huntington, Thomas W.: Open Treatment of Fractures, 407; Spinal Cord Anæsthesia, 422.

Hutchings, Willard H.: Note on Catgut Sterilization, 693.

Hydrocephalus, Internal, Operative Cure of, 411.

I

Ileus from Gall Stone Obstruction, 321.

Induced Cell-Reproduction and Cancer, by Hugh C. Ross, Review of, 713.

Infections, a Study of the, 433; Thoracic, Post-Operative Treatment of, 549, 568.

Intestine, Extensive Removals of the, 669.

Intratracheal Insufflation as a Method of Anæsthesia, 417, 572.

Intussusception Caused by a Lipoma of the Descending Colon, 344.

J

Janeway, Henry H.: The Management of Post-Operative Thoracic Infections, 549, 568.

Jaw, Lower, Method for Relieving Ankylosis of, 145; Removal of Cancer of, 570.

Jopson, John A.: Giant Appendix, 573.

K

Keen, W. W.: Anæsthesia by Intratracheal Insufflation, 572.

Kelly, James A.: The Treatment of Lacerated and Incised Wounds of the Extremities, 696.

Kidney, Acute Hæmatogenous Infection of the, 577; Horseshoe, Suppuration in Half of, 355, 413; Malignant Papillary Adenoma of the, 585.

Kivlin, Charles F.: Primary Ovarian Pregnancy, 206.

Knee-Joint, Septic, Drainage of, 258.

Koll, Irvin S.: Polyp of Urinary Bladder in an Infant, 589.

L

Lahey, Frank H.: Prolapsed Spleen with Acute Torsion, Splenopexy, 612.

Le Conte, Robert G.: Spinal Cord Anæsthesia, 422.

Leg, Compound Fracture of, Treated with Chinosol, 257.

Leucocyte Count, Value of, in Acute Surgical Diseases, 721.

Lilienthal, Howard: Arteriovenous Anastomosis, 425; Bilateral Temporomaxillary Ankylosis, 145; Intratracheal Insufflation of Anæsthetics, 420; On the Treatment of Epispadias in the Female, 404.

Linitis Plastica, 625.

Lipectomy in the Treatment of Obesity, 706.

Lithopedion with Ectopic Gestation, 251.

Lower Lip, Plastic Restoration of, 133.

Lund, Fred B.: Arteriovenous Anastomosis, 425; Obstruction of the Ileum by a Large Gall-Stone, 321; Open Treatment of Fractures, 408; Remarks upon Anæsthesia, 420.

Lusk, William C.: Anatomy of Spinal Puncture, Considerations on Technic and Paralytic Sequels, 449; Compound Fracture of Leg Treated with Chinosol, 257; Drainage of a Septic Knee-Joint, 259; Supracondyloid Fracture of Femur Treated by Lane Plate, 256; Unilateral Wiring of Fractured Radius, 255.

Lyle, Henry H. M.: Linitis Plastica, 625; Mesenteric Cyst, 248; Gastrojejunostomy for Cirrhosis of the Stomach, 244; Perforating Duodenal Ulcer, 243; Perineal Excision of Adenocarcinoma of the Rectum, 234; Treatment and Cure of Carcinoma of the Cervix by Operation, 243; Ureteral Calculus, 234.

M

MacKenzie, Kenneth A. J.: Open Treatment of Fractures, 410; Surgical Treatment of Fistula in Ano without Mutilation of the Sphincter, 360, 415; Tumor of Horseshoe Kidney, 414.

Maclaren, Archibald: Pyloroptosis; Gastric Atony as the Original Cause of Neurasthenia and its Cure, 306, 426.

Magnuson, P. B.: Approximation of the Ends of Fragments in Fractures with Contraction of the Attached Muscles, 227.
Malignant Disease, Treatment of Far-Advanced, 297.
Mammary Gland, Fibro-Epithelial Tumors of, 517.
Manual of Gynæcology, by Thomas W. Eden, Review of, 431.
Martin, Edward: The Open Treatment of Fractures, 404.
Martin, Walton: Ectopic Gestation, Lithopedion, 251; Mesenteric Thrombosis, 252; Removal of Drainage Tubes Left in the Pleural Cavity, 250; Removal of Stone from the Common Duct, 249.
Mastitoides Carcinoma, a Study of, 69.
Mayo Clinic, Collected Papers by the Staff of St. Mary's Hospital, Review of, 718.
Mayo, Charles H.: Extirpation of Tumors of the Vomer Through the Roof of the Mouth, 302, 426.
Mayo, William J.: Suppuration in One-half of a Horseshoe Kidney, 413; Ulcer of the Stomach and Duodenum with Special Reference to the End Results, 313, 427; Unsatisfactory Results of Operation in Cases of Atonic Stomachs, 426.
McArthur, Lewis L.: Operative Cure of Internal Hydrocephalus, 411; Surgery of the Gall-Bladder anu Bile-Ducts, 428.
McCoy, John C.: Splenopexy for Rupture of the Spleen, 597.
Meltzer, S. J.: Intratracheal Insufflation as a Method of Anæsthesia, 417.
Mesenteric Cysts, 115, 248; Thrombosis, 253.
Meyer, Willy: The Management of Post-Operative Thoracic Infections, 568.
Miller, Morris Booth: Frontal Encephalocele, 283; Posterior Gastrojejunostomy Subsequent to Operation for Perforating Gastric Ulcer, 278; Stab Wound in Abdomen, Evisceration Through, 279; Stab Wound in Chest, 281.
Mitchell, A. B.: Gastric and Duodenal Ulcer, 806.
Mitchell, O. W. H.: Germicidal and Osmotic Actions of Picric Acid, 230.
Monks, George H.: Dislocation of the Hip Complicated with Fracture of the Femur, 393.
Moore, James E.: Chloroform Anæsthesia, 416.
Moschcowitz, Alexis V.: Cases of Hernia with Unusual Features, 263.
Mouth, Cancer of the Floor of, and of Lower Jaw, Removal of, 570.
Murphy, John B.: Epispadias in the Female, 403.
Muscle Grafting for Gunshot Wound of Shoulder, 679.

N

Nancrede, Charles B. G. de: Anæsthetics in Military Surgery, 423.
Nasolachrymal Passages, Variations in the Anatomy of, 148.
Neff, James M.: Ligation of the First Portion of the Left Subclavian Artery, 503.
Neurasthenia, Caused by Pyloroptosis and Gastric Atony, 306, 426.
New York Surgical Society, Transactions of the, 234, 255, 567, 859.
Ney, Grover C.: Mesenteric Cysts, 115.

O

Obesity, the Surgical Treatment of, by Lipectomy, 706.
Œsophagoscopic and Gastroscopic Examinations, 567.

Omentum, Cysts of the, 617; Torsion of the, with Suppurative Pancreatitis, 269.
Oudin High-Frequency Current in the Treatment of Tumors of Urinary Bladder, 208.
Ovarian Pregnancy, Primary, 206.

P

Pancreas, Considerations Relating to the Pathogenesis and Diagnosis of Surgical Diseases of, 798; Diseases of the, by Eugene L. Opie, Review of, 430.
Pelvic Surgery, Apparatus Designed to Facilitate, 160.
Peritoneal Adhesions, Studies on, 758.
PHILADELPHIA ACADEMY OF SURGERY, Transactions of the, 124, 276, 286, 567.
Picric Acid, Germicidal and Osmotic Actions of, 230.
PILCHER, PAUL M.: Intraperitoneal Operation for Carcinoma of the Bladder, with New Method of Treating the Divided Ureter, 593; Practical Cystoscopy, Review of, 716.
Pisiform Bone, Simple Fracture of, 229.
Plastic and Cosmetic Surgery, by Frederick S. Kolle, Review of, 717; Restoration of the Lower Lip, 133.
Pleural Cavity, Removal of Drainage Tubes from, 250.
Pneumococcus Infections of the Extremities, 390.
Pott's Disease, Operative Treatment of Deformity of, 841.
POWERS, CHARLES A.: Acute Pneumococcus Infections of the Extremities, 390; Anæsthetics in Tuberculous Patients, 419; Open Treatment of Fractures, 409.
Practice of Surgery, by James Gregory Mumford, Review of, 139.
Pregnancy, Primary Ovarian, 206.
PRIMROSE, ALEXANDER: Open Treatment of Fractures, 408.
PRINCE, HOWARD L.: Modified Autogenous Grafting and Turning Skin Flaps to Cover Granulating Surfaces, 848.
Prostate, Large, 270.
Pyloric Adhesions Freed by Operation, 262.
Pyloroptosis, a Cause of Neurasthenia, 306, 426.
Pylorus, Congenital, Hypertrophic Stenosis of the, 167.

R

Radium, Effects of, in the Treatment of Angioma of the Face, 237; of Goitre, 235; of Macroglossia, 238; of Primary Carcinoma of the Liver, 236; of Sarcoma of the Parotid, 236.
Radius, Fracture Treated by Wiring, 255; Osteotomy of, 130.
RANSOHOFF, JOSEPH: Operative Cure in Internal Hydrocephalus, 412; Open Treatment of Fractures, 407; Remarks upon Anæsthesia, 421.
Rectum, Adenocarcinoma of, Perineal Excision, 234; and Vagina, Excision of, for Cancer, 234.
RICHARDSON, EDWARD H.: Studies on Peritoneal Adhesions, 758.
ROBERTS, JOHN B.: Everted Dorsal Dislocations of the Hip, 371, 410; Open Treatment of Fractures, 407, 576; Remarks upon General Anæsthesia, 419.
ROSS, GEORGE E.: Carcinoma of the Appendix, 277; Compound Comminuted Fracture of the Forearm, 277; Perforated Duodenal Ulcer, 279; Perforating Ulcer of the Sigmoid Flexure of the Colon, 276; Tuberculous Arthritis of the Elbow, 278.

S

Scapula, Congenital Elevation of, 126.

Schaeffer, J. Parsons: Variations in the Anatomy of the Nasolachrymal Passages, 148.

Schley, W. Scott: Case of Mesenteric Thrombosis, 252.

Schumann, Edward A.: A Study of Carcinoma Mastitoides, 69.

Scoliosis, Fixed, Method of Correcting, 862.

Sherren, James: A Double Gall-Bladder Removed by Operation, 204.

Shoulder, Gunshot Wound of the, Muscle Grafting for, 679.

Simmons, Channing C.: Fibro-Epithelial Tumors of the Mammary Gland, 517.

Sinclair, H. H.: Splinting Skin Grafts and Granulating Surfaces, 575.

Skin Grafts, Splinting, 575.

Sphenoid Bone, Fracture of Posterior Clinoid Process of the, 270.

Spica, the Shoulder Plaster, 861.

Spinal Puncture, Anatomy of, Technic and Sequelæ, 449.

Splenectomy for Rupture of the Spleen, 597.

Splenopexy, for Prolapsed Spleen, with Acute Torsion, 612.

Squier, J. Bentley: Malignant Papillary Adenoma of the Kidney, 585.

Sterilization of Catgut, Note on, 693.

Stiles, Harold J.: Epispadias in the Female and its Surgical Treatment, 403; Operative Cure in Internal Hydrocephalus, 413; Satisfactory Results from Gastro-Enterostomy in Atonic Stomachs, 426; Treatment of Irreducible Dislocation of the Hip, 410; Value of Chloroform as an Anæsthetic, 422.

Stillman, Stanley: Open Treatment of Fractures, 409; Unsatisfactory Results of Operation in Gastritis, 426.

Stomach, Atony of, a Cause of Neurasthenia, 306, 426; Cirrhosis of the, 625; Cirrhosis of, Gastrojejunostomy for, 244; and Duodenum, Ulcer of the, with Special Reference to the End Results, 313, 427.

Stone, Harvey B.: Lateral Vascular Anastomosis, 496.

Subclavian Artery, Ligation of First Portion of Left, 503.

Summers, John E.: End Results of Gastric Ulcer, 427; Some Modifications of Technic in the Surgery of the Gall-Bladder and Bile-Ducts, 110.

Supplies, Operating, New Container for Sterilized, 854.

Surgery of Childhood, The, Including Orthopædic Surgery, by De Forrest Willard, Review of, 141; The Practice of, by James Gregory Mumford, Review of, 139.

Syms, Parker: Aspirating Cup Used as a Tractor, 271; Decompression for Suspected Tumor of the Brain, 268; Fracture of the Posterior Clinoid Process of the Sphenoid Bone, 270; Gangrenous Appendicitis, 271; Large Prostate, 270; Torsion of the Omentum, Suppurative Pancreatitis, 269; Traumatic Asphyxia, 267.

T

Talipes Equino Varus, Extreme, 862.

Taylor, Walter H.: Apparatus Designed to Facilitate Pelvic Surgery, 160

Temporomaxillary Articulation, Bilateral Ankylosis, Operation for, 145.

TENNANT, C. E.: Mechanical Aids to Hollow Visceral Anastomosis. 500.

THOMPSON, JAMES E.: Final Results of Transplanting Ureters into Colon, 404; Suppuration in Half of a Horseshoe Kidney, 355, 413.

Thoracic Infections, Post-Operative Management of, 549, 568; Surgery under Intratracheal Insufflation Anæsthesia, 749.

Tibia, Giant-Celled Sarcoma of the, 272.

TINKER, MARTIN B.: Modified Autogenous Grafting and Turning Skin Flaps to Cover Granulating Surfaces, 848.

TORRANCE, GASTON: Vesicovaginal Fistula from Penetration of Floor of the Bladder by Horn of a Bull, 287.

Transplantation of Free Flaps of Fascia, 734.

Treatment of Fractures, The, by Charles L. Scudder, Review of, 719; Operative, of Deformity of Pott's Disease, 841.

Tuberculous Arthritis of the Elbow, 278.

Tumor, Sacrococcygeal, Congenital, 284.

U

Ulcer, Gastric and Duodenal, 806.

Ureter, Divided, in Operation for Carcinoma of Bladder, New Method of Treating, 593.

Ureteral Calculus, Extraperitoneal Removal, 243.

Ureters, Transplanting of, into Colon, Final Results of, 404.

Urethra, Excision of, with End-to-End Suture, 128.

Uterus, Carcinoma of the Cervix, Operation for, 243.

V

Vaginal Cœliotomy, by S. Wyllis Bandler, Review of, 711.

Vascular Anastomosis, 496.

Vesicovaginal Fistula from Penetration of Floor of the Bladder by Horn of a Bull, 287.

Visceral Anastomosis, Mechanical Aids to Hollow, 500.

Vomer, Extirpation of Tumors of, 302, 424.

W

WALKER, JOHN B.: Fracture of the Hip Treated by the Abduction Method, 863; Operative Treatment of Fracture of the Femur, 260.

WALTON, ALBERT J.: The Pathology and Symptomatology of Gall-Stones, 83, 176.

WHARTON, HENRY R.: Intussusception Caused by a Lipoma of the Descending Colon, 344.

WHITALL, J. DAWSON: Extensive Removals of Intestine, 669.

WHITMAN, ROYAL: Arthroplasty for Bony Ankylosis, 860; Backward Dislocation at Elbow, 862; Epiphyseal Fracture at the Upper Extremity of the Humerus, 861; Extreme Talipes Equino Varus, 862; Fracture of the Neck of the Femur Treated by the Abduction Method, 859; A Method of Correcting Fixed Scoliosis, 862; The Operative Treatment of the Deformity of Pott's Disease, 841, 864; The Operative Treatment of Paralytic Calcaneus, 860; The Shoulder Plaster Spica, 861; The Treatment of Disease of the Hip-Joint by Arthrodesis, 862.

WILKINSON, A. L.: Mesenteric Cysts, 115.

WOOD, ALFRED C.: Congenital Sacrococcygeal Tumor, 284; Paraffin Injection as a Cure for Inguinal Hernia, 286.

Wounds of the Extremities, Treatment of Lacerated and Incised, 696.

Y

YOUNG, JAMES K.: Actinomycosis, 132.

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